UNIV. OF
TORONTO
LIBRARY

Digitized by the Internet Archive
in 2010 with funding from
University of Toronto

http://www.archive.org/details/chemicalage25newy

Tecknol
C

THE CHEMICAL ENGINEER

VOL. XXV. FEBRUARY---MARCH, 1917 No. 17

15-8217
14/1/21.

Published Monthly by the

McCready Publishing Company.

ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

LAURANCE T. CLARK, Editor

CHARLES B. DAVIS, F. C. S., Consulting Editor

Application made for entry as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS FEBRUARY-MARCH, 1917

Page

Ultra Violet Light: Its Application in Chemical Arts. Part I 2
Carleton Ellis and A. A. Wells.

The Colorimetric Test for the Determination of Organic Impurities in Sands 9
Prof. Duff A. Abrams and Oscar E. Harder.

Chemical Control in the Leather Industry 12
David Quick Hammond.

Crystallization of Cream of Tartar in the Fruit of Grapes 15
William B. Alwood.

Improvements in Waste Disposal Plants 16
Gustave R. Tuska.

Chemistry and Engineering 18
Dr. Charles Carpenter.

Preparation of Picric Acid and Other Nitrated Phenols 22
Carleton Ellis, Louis Rabinowitz and A. A. Wells.

American Dyes—After the War 26
B. R. Armour.

The Estimation of Free Acids in Solution 28
F. W. Richardson, F. I. C.

The Recovery of Glycerine 31
G. A. Moore.

Chemical Investigation, Efficiency and Control 33
Conducted by Charles B. Davis.

Page

Aniline Dyes in the United States 34
I. F. Stone.

Fumigating Baled Cotton: the Hydrocyanic Acid Gas Process 37

Government Investigates Fatal Explosions of Oxygen 38

Distillates: News Notes of Chemical and Allied Industries 39

March Prices of Chemicals 40

SPECIAL NOTICE.

This issue of "The Chemical Engineer" combines the February and March numbers, all subscriptions being extended accordingly. The April issue will be published during the first week in that month, and thereafter the publication date will be on the first of each month.

BUSINESS CHEMISTRY.

One of the great needs of industrial chemistry in America is the development of the business sense of the chemist himself. Laboratory results must be presented to the business world in a way so as to inspire financial confidence. The tendency to look for quick returns has been altogether too great. Oftentimes years of careful research are necessary before tangible financial results can be obtained, and the work of the industrial chemist must be such as to command the necessary financial backing during those years. It is of vital importance that he be able to present his technical knowledge in terms which will be understood by the man of business.

In foreign countries, particularly in Germany, research work has been backed to the ultimate limit, not only by the Government, but by private capital. Similar work for the future is being done to a certain extent in this country, but only to a very limited degree. During the next few years the economic conditions which will undoubtedly develop will place a premium on careful, painstaking research work—work which will be sure rather than showy. We have just begun to realize what is meant by the elimination of waste and the utilization of wastes. The chemist and the efficiency expert must labor side by side.

If we are to enter into the World War, there will be plenty of work, vitally important work, for the American chemist, but when the war ends his place in the business fabric of this country will be of even greater importance.

ULTRA VIOLET LIGHT.

Its Application in Chemical Arts.

By Carleton Ellis and A. A. Wells.*

This Is the First of a Series of Articles Dealing with Investigations Conducted by the Writers Into the Possible Applications of Ultra Violet Light, and the Results Obtained Following the Exposure of Various Bodies to the Action of Its Rays. In the Present Article the Work of Other Investigators in This Field is Discussed. Part II Will Appear in the Next Issue.

Introduction.

DURING recent years the development of lamps adapted for the production of ultra-violet light have made possible new types of apparatus yielding powerful ultra-violet rays, thus placing at the disposal of the chemist the means for subjecting various inorganic and organic bodies to the action of this highly actinic form of light under various conditions. The result has been that in the last few years a large amount of research has been carried out in this field, some of which is of an extremely interesting character, leading directly to certain practical applications or indicating the possibility of such applications of ultra-violet light

It is the purpose of the present article to discuss a number of these applications and also to embrace a synopsis of the greater part of the work that has been done in this field. The result of investigations conducted in this laboratory in connection with the exposure of certain organic bodies to ultra-violet light will be briefly discussed.

The first portion of the paper is devoted to a general review of the work heretofore carried out on the chemical effects of ultra-violet light.

PART I

METALS AND THEIR COMPOUNDS.

Jacquier (British Patent 17,790, Aug. 2, 1913) describes a process of *precipitating metals* from solutions of their salts by treatment with artificial ultra-violet rays in the presence of aluminum. The process may be assisted by sunlight. Mercury vapor lamps are suspended between aluminum plates in the tank containing the solution to be treated.

Svedberg (Ber. 1909, 42, 4375-4377) has succeeded in preparing *colloidal solutions of metals* by the application of the observation of Lenard and Wolf (Ann. Phys. Chim., 1889, 37, 443) that certain substances, especially metals, are disintegrated when exposed to ultra-violet rays. Pieces of metal, the surfaces of which had been carefully freed from oxide, were placed in a shallow dish containing a dispersion oxide medium, and exposed to the rays from a Heraeus quartz mercury arc lamp at a distance of a few centimeters. After a few minutes colloidal solutions were obtained from silver, copper, tin and lead, but platinum, aluminum and cadmium remained practically unaffected. The action was especially marked in the case of lead, which yielded a colloidal solution in ethyl alcohol, and a milky liquid, probably containing colloidal lead hydroxide, in water. Experiments with silver and lead in water, ethyl alcohol, isobutyl alcohol, ether, acetone, ethyl acetate, and amyl acetate showed that the nature of the dispersion medium had a great influence on the results. It is possible to prepare solutions by this method, the colloidal particles of which are very small, and of practically uniform size.

Following Svedberg's observation that metals are disintegrated at the surface and yield colloidal particles when covered with water or alcohols and exposed to ultra-violet rays, *Kimura* (Kyoto. 1913, 5, 253) describes experiments, chiefly with *silver, copper* and an *alloy of cadmium* 90, *antimony* 10 per cent. In a vacuum no corrosion takes place, in air there is a very slight corrosion, in oxygen somewhat more, and in water strong corrosion, under the influence of the rays. The mechanism of the action is discussed and photomicrographs of the corroded surfaces of the metals are given.

Experiments with Silver.

Nordenson (Kolloidchem. Beihefte 7, 110-36, 1915) continued the experiments of Svedberg. A plate of *silver* was immersed in alcohol and exposed to ultra-violet light and the loss in weight determined from time to time. No quantitative relation between the colloid formation and the time and temperature could be established owing to experimental errors. A qualitative investigation of the formation of colloids of metals when immersed in water, alcohol and other solvents and exposed to ultra-violet, Roentgen or radium rays was continued. It was found that the action of Roentgen and radium rays was similar to, but weaker than that of ultra-violet rays. Silver gave a metallic colloid. *Gold, platinum, iron, cobalt, nickel, chromium, manganese* and *bismuth* did not form colloids. *Copper, mercury, zinc, lead* and *tin* gave colloidal formations, but their nature could not be established. Because of the easy oxidation of the metals it could not be determined whether or not aluminum, magnesium and cadmium formed colloids. On immersing pure silver in pyridine or benzene no colloid was formed, but in ethyl alcohol, methyl alcohol, acetone and water the metallic colloid was formed and identified. The colloid formation is due to the activity of the rays in forming hydrogen peroxide which attacks the metal, forming an oxide or hydrate, which in turn is dissolved in the crystalloid form, and is then reduced to metallic colloid by the reducing action of the light rays. This could be substantiated in that if a piece of silver is immersed in a 0.01 per cent. hydrogen peroxide solution and the resultant solution treated with a reducing agent colloidal silver is formed. The other metals which are more easily oxidized (copper, mercury, zinc, lead and tin) are similarly attacked by hydrogen peroxide and the reaction accelerated by the light, but a metallic colloid is not formed.

---

*All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

There appears to be a difference of opinion in regard to the effect of ultra-violet rays on colloids. (Zeit. angew. Chem. 1914, 18, No. 2.) It has been stated by Wiemarm that exposure to ultra-violet light causes the size of the particles of colloids to be reduced.

FORMATION OF OZONE FROM OXYGEN.

Fischer and *Braehmer* (Ber. 1905, 38, 2633) have published an article on the production of ozone by the ultra-violet light. One of these investigators devised a form of mercury arc lamp containing a double walled quartz vessel through the annulus of which a gas can be passed, and thus be exposed to the radiation of the arc. The lamp can be immersed in water and its outer glass casing kept cool, and a stream of water (or other cooling liquid) can be passed through the interior of the quartz tube, cooling one coating of the annulus, and hence, as the annular space is only about a millimeter across, cooling the contained gas very considerably. Through this apparatus pure oxygen, generated electrolytically from dilute sulphuric acid, was passed and exposed to the radiation from the arc. The total quantity of ozone formed during an experiment (15 minutes) was determined, and hence, from a knowledge of the quantity of gas that had passed, the percentage by weight in the ozonized gas was known.

The results showed that without any cooling, when the temperature rose to 270°C., no ozone was formed. Cooling the gas by water, increasing its speed while maintaining the temperature constant at 15°C., or lowering the temperature, increased the yield of ozone. Under constant conditions of cooling water, by increasing the current through the lamp from 2 to 6½ amperes, the yield was increased, but further rise of current diminished it, no doubt because of the rise of temperature which it caused. Increase of the oxygen stream corresponding to a rise from 2 to 4 amperes in the generating vessel nearly doubled the yield of ozone, but slightly decreased the percentage in the issuing gas. The effect of moisture in the oxygen was examined, but no conclusions on the matter were drawn. The experiments indicate that the conversion of oxygen into ozone by ultra-violet light is opposed by the decomposition of ozone into oxygen, the speed of which reaction increases rapidly with rise of temperature. These experiments support the view that the production of ozone in the Siemens tube is due to the influence of ultra-violet radiation.

Regener and *Fischer* (Handbuch der Diochemischen Arbeitsmethoden, Abderhalden, Vol. IV, 834) have observed that when working with ultra-violet light it should be remembered that ozone is developed and that reactions may be brought about because of the presence of ozone.

MISCELLANEOUS ORGANIC AND INORGANIC COMPOUNDS.

Per-acids (British Patent No. 16,849, July 22, 1913) are prepared by treating aldehydes with oxygen, or oxygen containing gases at low temperatures, preferably with the exclusion of injurious impurities such as water and manganese compounds. The reaction is facilitated by the use of chemically active rays. On allowing per-acetic acid, obtained from acetaldehyde, to attain room temperature, it is decomposed by the remaining aldehyde into acetic acid. The per-acids may be used to prepare hydrogen peroxide.

From results which have been shown previously that *xylene* mixed with an aromatic nitro-hydrocarbon contained more active oxygen after exposure to light and oxygen than pure xylene so treated. *Suida* (Ber. 1914, 47, 467-472; Monats. Chem. 1912, 33, 1268) has found that the presence of a nitro-compound reduced the total yield of oxidation product, but that considerable quantities of toluic aldehyde were present. Thus in the presence of a nitro-hydrocarbon the less stable products of oxidation (aldehydes and peroxides) remained, while the pure chemical reaction (the decomposition of these primary products to the next higher and more stable stage of oxidation) was delayed. It was possible by cooling in carbon dioxide and ether to bring almost to a standstill the decomposition of the benzene hydro-peroxide (formed from benzaldehyde by the action of ultra-violet light). The product of the primary auto-oxidation process could not be isolated, as it decomposed into benzoic acid within a few minutes after removing it from the cooling mixture.

Photochemical Reduction of Ketones.

Boeseken and *Cohen* (Wetenschappen 23, 765-86, 1914) studied the photochemical reduction of *ketones* by anhydrous alcohol, both by direct sunlight and light from a quartz mercury arc lamp. Five grams of the ketone in 50 cubic centimers of dry alcohol sealed in ordinary glass tubes was exposed to the light. Reduction in this manner gave only pinacols. The reaction velocity is independent of the concentration of ketone and proportional to the concentration of the alcohol and may be represented as follows: 2 ketone + alcohol = pinacol + aldehyde. The temperature coefficient was very small. The rate of pinacol formation depends greatly on the alcohol employed, methyl alcohol and allyl alcohol acting slower than other primary and secondary alcohols; also on the ketone, benzophenone being reduced more rapidly than other ketones. Many were not reduced at all. The relative rates in different alcohols are the same. The active light in the ketone reduction lies between 400 and 430, and probably at or near the rays 404.7 and 407. The relation of the rate of pinacol formation is the same in sunlight and in mercury light. When two ketones are present simultaneously, one absorbs a part of the rays needed by the other; this is also evident when the light, after passing through one, is allowed to act on another. This interference is greater than would be expected.

Schmitz & Co. (British Patent No. 3,053, Feb. 5, 1914) have prepared *esters of phenol* homologues, halogenized in the side chain by treating the esters alone or in suitable solvents (such as carbon tetrachloride) with halogen in the presence of light, especially from a source rich in ultra-violet rays. Halogen carriers may be employed if necessary.

Winther and *Oxholt.Howe* (Z. Wiss. Phot. 14, 196-212, 1914) have made a study of the photochemical decomposition of *iron oxalate, succinate, tartrate, citrate* and *acetate* for short wave lengths, chiefly ultra-violet. The reaction velocity is approximately constant throughout the whole change. The "quantum-sensitiveness" is greater than unity, showing a catalytic light reaction. In terms of unit quantity of incident light, the sensitiveness at a given concentration increases as the absorption co-efficient of the solution decreases. This may be ascribed to the existence of two substances, one photosensitive, the other insensitive and causing most of the absorption. The per cent. effect of the incident light also increased with increasing dilution.

Kailan has published a pamphlet (Institut für Radiumforschung, Wein. 1913), in which he discusses the decomposition of various *organic acids* by the ultra-violet light, the action of the rays on *amyl alcohol* and on *iodine* and *iodides* in various strengths of acid solution.

Work of Berthelot and Gaudechon.

Berthelot and Gaudechon (Comptes. rend., 1910, 150, 1169) have made a study of the chemical effects of the ultra-violet rays on a variety of substances. *Acetylene, ethylene, cyanogen* and *oxygen* show in every case a diminution in volume owing to polymerization, no other chemical change being observed. Acetylene is converted into a yellow solid (more readily under reduced pressure or when mixed with an inert gas such as hydrogen or nitrogen); ethylene gives a liquid polymer with the odor of rancid fat; cyanogen is converted into paracyanogen; and oxygen to a small extent into ozone

Cyanogen is oxidized practically completely to carbon dioxide and nitrogen, a mixture of *ammonia* and *oxygen* yields nitrogen and water, but free *hydrogen* is not oxidized appreciably by oxygen at the ordinary temperature under similar conditions. By the action of ultra violet rays on mixtures of acetylene and ethylene respectively with oxygen, some formic acid is produced. (Comptes. rend., 1910, 150, 1327.)

Air or mixtures of nitrogen and oxygen produced no appreciable effect. *Nitrous oxide* alone or mixed with oxygen produced nitric acid. *Sulphur dioxide*, alone or mixed with oxygen, yielded free sulphur and sulphuric acid. (Comptes. rend., 1910, 150, 1517.)

The modes of decomposition are classified according to the constitution of the compounds—i. e., alcohols, aldehydes, ketones and acids. (Comptes. rend., 1910. 151, 1349.)

Solutions of *Ammonia* (Comptes. rend., 1911, 152, 522) in the presence of pure oxygen or of air when exposed at a temperature of 35°-50°C., for from 3 to 9 hours at a distance of 3-6 cm. from a lamp of 110 volts, are oxidized to nitrites. Nitrates were in no case formed. *Ammonium salts* were also oxidized to nitrites, the reaction being slower in the cases of the sulphate and chloride than in that of the carbonate. Urea was also converted first into ammonia and then into nitrite. Other organic nitrogen compounds—e. g., *ethyl* and *methylamine, guandine, hydroxylamine, acetamide, acetonitrile*, etc., behaved similarly. Stress is laid on the close analogy between the effects of the rays and the action of enzymes. The rays are further able to convert *nitrates* into nitrites, and to decompose concentrated solutions of *ammonia nitrite* with liberation of nitrogen.

Explosives.

Nitroglycerine (Comptes. rend., 1912, 154, 201), 0.10 grm. after 30 minutes' exposure at 20 mm. gave 1.32 c.c. of gas containing carbon dioxide 24, carbon monoxide 10.5, nitrogen 17.5, nitrous oxide (N_2O) 8.5 and nitric oxide (NO) 39.5 per cent. Some nitric oxide was also destroyed in attacking the mercury in the testing apparatus. The high percentage of nitric oxide explains its presence in the products of decomposition of powders containing nitroglycerine. A piece of nitrocellulose (collodion) 15 by 51.6 mm., after 2 hours at 20 mm., gave 0.87 c.c. of gas, the percentages of its constituents in the same order as above being 25.5, 19.5, 39, 7, 9. Collodion, though less nitrated than the French service smokeless powders, decomposes more readily and evolves a notable amount of nitric oxide. This shows the use of the gelatinization adopted for this powder and of the stabilizers incorporated in it. Comparison of two powders of the same age and make stabilized by amyl alcohol and diphenylamine respectively showed that at 20 mm. (temp. 75°C.) *amyl alcohol* is the more efficient, the latter powder giving off less gas, and the gas containing a very much lower percentage of nitric oxide than the former. (As new powders of the former type do not show nitric oxide in the products of their "photolysis" the source of it in this powder, which was six years old, is no doubt the nitrosodiphenylamine formed during the slow decomposition of the powder). At 50 mm. (temp.

40°C.), on the other hand, *diphenylamine* is the more efficient stabilizer. Similar results were obtained with two more recently prepared naval powders, save that these evolved no nitrogen oxides. When the powders were treated with alkali (1 gm. with 20 c.c. of N/2 potassium hydroxide for 30 minutes at 15°) it was found that the diphenylamine powder showed less decomposition than that stabilized with amyl alcohol. A *damaged naval powder,* in which the brownish yellow plates showed whitish stripes, was examined by the lamp. At both distances the damaged parts gave off more gas than the unaltered parts, and this gas contained from 12 to 30 per cent. of nitrogen oxides, while the gas from the unaltered parts contained none.

Effects of Various Atmospheres.

The experiments (Comptes. rend., 1912, 154, 514) were repeated in oxidizing (oxygen), reducing (hydrogen) and inert (carbon dioxide, nitrogen) atmospheres. With oxygen, two-thirds of the free oxygen disappeared and added its oxidizing effect to that of the oxygen of the nitrocellulose. With hydrogen, about one-quarter disappeared, forming water and formaldehyde. With carbon dioxide much depends on the temperature; at 25°-30° C. (70-80 m.m. from the lamp) there is absorption, due no doubt to the solvents and stabilizers which are basic in their character; at 40°C. (50 m.m. distance) no change in volume occurs; at 75°C. (20 m.m. distance) there is disengagement of carbon dioxide from the powder and the final volume shows an increase. Nitrogen has no effect on the evolution of nitrogen or nitrous gases from the powder.

Heating *smokeless powders* to 110°C. for periods of from 4 to 110 hours produced no effect on their behavior under the lamp, save that due to the fact that a certain quantity of the solvent in the powder was volatilized by the heating; but no nitric oxide was produced, showing that much longer periods of heating would be needed to "age" a powder artificially.

Picric acid, like other aromatic compounds, was found to be very stable under exposure; no decomposition took place at 50 m.m. distance, and after 3 hours at 20 m.m. only a slight browning occurred and evolution of about 0.7 c.c. of gas. *Ammonium picrate* was still more stable and showed no decomposition even at 20 m.m. from the lamp.

Under the influence of ultra violet light (Comptes. rend., 1912, 155, 521) *acetylene* can be made to yield a solid yellowish polymerized product. *Ethylene* polymerizes to a thick liquid boiling above 100°C. and bearing some resembrance to caprylene. Allylene gives rise to a whitish solid. *Methane* shows no tendency to polymerize, but in the presence of oxygen it loses hydrogen and forms higher homologues of the paraffin series.

Decomposition of Carbonyl Organic Compounds.

Organic compounds (Comptes. rend., 1912, 155, 401-403) containing a carbonyl group show exceptional sensitiveness toward light. Solutions of *ketoses,* protected from the air, were found to be slowly decomposed by sunlight. One c.c. of a ten per cent. solution of dihydroxyacetone evolved 0.2 c.c. of almost pure carbon monoxide on exposure to sunlight for twelve hours. Erythrulose, lævulose, sorbose and perseulose were decomposed much more slowly, for with increase in the length of the carbon chain the photo-sensitiveness diminishes. A solution of lævulose produced only 0.54 c.c. of gas per c.c. in about two months' time. In all cases the gas evolved was almost pure carbon monoxide. The reaction which takes place under these conditions consists in the elimination of the carbonyl group and the conversion of the ketose into an alcohol containing one carbon atom less in the molecule. A similar reaction occurs under the influence of ultra-violet rays from a quartz mercury lamp, but it then proceeds much more rapidly and is accompanied by subsidiary reactions with the result that carbon monoxide produced contains some carbon dioxide, hydrogen and methane. Ketoses in the solid state are decomposed by ultra-violet rays in the same way as when dissolved in water.

Di-Saccharides.

Ultra-violet rays (Comptes. rend., 1912, 155, 1016) of relatively long wave length photolyze *di-saccharides* in two stages. In the first stage hydrolysis takes place without any evolution of gas, the second stage is characterized by a regular evolution of gas due to decomposition of the mixture of monoses produced in the first stage. The solutions remain neutral throughout the experiments, so that the photolysis of *sucrose* to dextrose and lævulose and of maltose to two molecules of dextrose is not brought about by the formation of acid in the solutions, as has been suggested.

Of the three compounds studied, viz.: acetaldehyde, ethyl alcohol and acetic acid (Comptes. rend., 1913, 156, 68), only acetaldehyde is decomposed by sunlight (wave length greater than 0.3). Light from a mercury lamp screened by thin glass which absorbs all rays of wave length less than 0.3, decomposes acetaldehyde in accordance with the equation $CH_3.CHO = CO + CH_4$. Frequently the proportion of methane to carbon monoxide actually found is somewhat less than corresponds to this equation, for the light causes polymerization of some of the aldehyde to paraldehyde, which is then photolyzed to carbon monoxide and ethane or more complex substances. These latter reactions are most readily produced by the extreme ultra-violet rays. Direct rays from a mercury lamp, without any interposed screen, photolyze not only acetaldehyde but ethyl alcohol and acetic acid. *Ethyl alcohol* is decomposed primarily into acetaldehyde and hydrogen (J. S. C. I. 1911, 1086), but usually some carbon monoxide and ethane are formed by the further decomposition of the aldehyde. By the photolysis of *acetic acid* a gas was obtained which contained 44 per cent. of carbon dioxide, 17 of carbon monoxide and 39 per cent. of combustible gases (J. S. C. I. 1910, 1081). All the results described above relate to photolysis in absence of air. In presence of water the reactions take substantially the same course, but there is a tendency toward the formation of acid products.

Verification of Law.

The law of inverse stability of compounds in relation to their increase in molecular weight has been verified by experiments on the compounds of the nitrogen and carbon groups when under illumination (Comptes. rend, 1913, 156, 1243-1245). With a large 220-volt mercury lamp an almost complete decomposition of ammonia was obtained in two hours. With *hydrogen phosphide* in a quartz tube at 20 m.m. from the lamp, decomposition was evident in a few minutes, while in glass tubes it was not quite complete in 30 min. *Hydrogen arsenide* in glass glass tubes was unaffected after two hours, but in a quartz tube a deposit of arsenic was formed in 15 seconds and decomposition was complete in 10 minutes, a mirror of arsenic being formed. *Methane* was not decomposed by the most intense illumination. *Zinc ethyl* gave zinc and pure ethane free from ethylene in 5 minutes. *Carbonyl chloride* in a quartz tube was decomposed in less than 5 seconds, but when in a glass tube no decomposition could be detected after two hours. *Sulphur fluoride* in a quartz tube was not decomposed by three hours' illumination.

The tendency of *carbon monoxide* (Comptes. rend., 1913, 157, 129-131) to form compounds under the influence of light is most pronounced with the lowest members of a series; it combines with chlorine, not with bromine or iodine; with oxygen or water, not with sulphur or hydrogen sulphide; with ammonia, not with phosphine or arsine.

Copper (Comptes. rend., 157, 129-131) also combines with chlorine, but not with bromine or iodine; with oxygen, but not with sulphur; with water, but not with sulphurated hydrogen; with ammonia, but not with phosphine or arsenurated hydrogen.

Oxides of carbon and water vapor (Comptes. rend., 1910, 150, 1690-1693) have, as stated, been made to react with each other by means of the light of the mercury vapor lamp. *Carbon monoxide* and oxygen produce a small amount of carbon dioxide, while the latter gas yields carbon monoxide when exposed to the rays in the presence of phosphorus. *Carbon dioxide* and hydrogen give water and formaldehyde (which, as is known, is capable of forming carbohydrates by successive condensations). Water can be made by the action of the rays on a mixture of *hydrogen*, and *oxygen* and *water vapor* itself is decomposed in the presence of carbon monoxide or phosphorus. *Formaldehyde* can be made directly from hydrogen and carbon monoxide, while formaldehyde is decomposed in the presence of nitrogen when exposed for several hours close to the lamp. Carbon monoxide and ammonia gas also give formaldehyde.

Photolysis of Oxalic Acid.

The photolysis of *oxalic-acid* (Comptes. rend., 158, 1791-3) consists in the primary decomposition into carbon dioxide and formic acid, followed by a secondary decomposition of the nascent acid into carbon monoxide and water by rays of long wave length and into carbon dioxide and hydrogen by waves of short length. This further shows that the radiant energy represents a lower form than thermal energy and that the frequency of vibration plays the same role in the former as does the temperature in the latter.

The photochemical effect of ultra-violet rays (Comptes. rend., 1910, 151, 395-397) is to lower the temperature of reaction, oxidations and decompositions being effected below 100°C., which otherwise are only produced at red heat, and to accelerate the reaction velocity. The reactions produced are reversible and the rays produce a high polymerizing power, *acetylene*, for instance, being converted not into benzene but into a solid polymeride. In these and other respects photochemical action resembles the chemical reactions produced in living organisms, especially in plants. Just as in plants, methyl compounds are met with much more frequently than ethyl compounds, so in photochemical reactions *methyl compounds* are easily synthesized, but the production of *ethyl compounds* is difficult and uncertain. In photochemical reactions with *ethylenic* and *acetylenic compounds* in presence of oxygen, the double and triple linkages are ruptured and simple acids formed, while in presence of ammonia cyclic compounds are formed. *Ethylene*, for example, yields first amino-ethylenes and then ring formation takes place with production of compounds of the pyrolidine and pyridine types, which may be regarded as the mother substances of alkaloids. In the case of aqueous solutions, the water also is decomposed to a small extent.

Experiments with Sugars.

The results of experiments with 10 per cent. aqueous solutions of different sugars, exposed for 10 hours at a distance of 2 c.m. from a 110-volt mercury vapor lamp, are as follows, so far as the gaseous reaction products are concerned: (1) *dextrose* gives approximately equal volumes of carbon monoxide and methane and about six times as much hydrogen; (2) *levulose* gives about ten times as much carbon monoxide as of methane; (3) *maltose* gives similar results to dextrose; (4) *sucrose* gives results intermediate between those given by dextrose and levulose. The numerical results, calculated to a basis of 100 vols. of combustible gas, are tabulated below:

	Carbon Monoxide	Methane	Hydrogen	Carbon Dioxide
Levulose	83	8	9	15
Dextrose	12	12	76	22
Maltose	12	11	77	21
Sucrose	45	8	47	16

Henry and Ranc (Giorn. form. chim. 62, 73, 1913) have found that ultra-violet rays cause the decomposition of *glycerol* with the production of formaldehyde and traces of other substances of an aldehyde nature. The decomposition takes place more readily in the presence of water.

Mathews and Elder (Eng. Pat. 11, 635, May 11, 1914) produce compounds of *sulphur dioxide* and *unsaturated hydrocarbons* by direct combination by exposing the mixed liquids to sunlight or ultra-violet light, or in some cases by heating. The examples given are the compounds with *pseudo-butylene* $(C_4H_8\,SO_2)_n$, *propylene, amlene* and *ethylene*. The butylene product is a horny or glassy, clear white solid, soluble in chloroform or tetrachlorethane and not easily inflammable. It can be used for making varnishes, transparent films, etc., and may be mixed with celluloid by first softening both with acetone. It renders the celluloid less inflammable.

Effects Upon Formaldehyde.

Pribram and *Franke* (Ber. 1911, 44, 1035) state that on exposure in a quartz vessel of a redistilled 30 per cent. solution of *formaldehyde* to light of short wave length from a mercury vapor lamp for some time, no external change can be noticed. If the resulting liquid is then distilled a white residue is left. The distillate possesses enhanced reducing properties acting rapidly on Fehling's solution in the cold. The residue when freed from formaldehyde is also strongly reducing and gives an osazone which melts at 168°C. This seems to indicate the formation of glycollic aldehyde, small quantities of which would pass into the distillate. The identification is not quite complete, however, since the melting point of the p-nitrophenylosazone is rather lower than that of the corresponding derivative of glycollic aldehyde. Control experiments with formaldehyde not exposed to ultra-violet light show no evidence of condensation. Coincidently with this (Monatsh. Chem., 1912, 33, 415) formic acid is produced along with a small amount of higher condensation products. The amount of acid formed is determined by the length of the exposure to the rays. Carbon dioxide and monoxide, hydrogen and methane are also produced in lesser degree. The oxygen necessary for the acid formation does not result from decomposition of the water present nor from ozone produced by the action of the rays upon air which may be present, since the formation is in no way hindered if air is excluded.

Stobbe (Ber. 47, 2701-3, 1914) states that *styrene* has never been completely transformed spontaneously into pure metastyrene, indicating that equilibrium is established between the polymerizing and depolymerizing reaction in such a homogeneous system. Solutions seemed better adapted for the study of this problem than the substances alone. Accordingly 8.58 per cent. solutions of styrene in benzene were kept in the dark on one hand and for two months in sunlight on the other; the first remained unchanged, while the refractive index changed from 1.49257 to 1.50048. In 2.2 per cent. benzene solutions of metastyrene the index of refraction of the illuminated solution changed from 1.49888 to 1.49842. Again 5 per cent. solutions showed the following refractive index after 0, 20, 32, 95 and 230 hours illumination in uviol tubes: styrene, 1.49883, 1.49911, 1.49939, 1.49994, 1.49994; metastyrene 1.50125, 1.50125, 1.50125, 1.50116, 1.50116. The illuminated solution of styrene gave a precipitate of metastyrene with alcohol; that of metastyrene decolorized $KMnO_4$; the solutions kept in the dark did not. Similar experiments with *stilbene* in benzene indicate that the equilibrium of stilbene lies very far toward the right, while in alcohol, ether, chloroform, trichlorethylene and pyridine there is apparently no polymerization.

Hydrolysis of Sucrose.

Euler and *Ohlsen* (J. Chim. Phys., 1911, 9, 416) exposed neutral solutions of *sucrose* to the rays from a Heraeus quartz mercury vapor lamp and determined at intervals the rotatory power, amount of invert sugar and acidity of the solutions. The experiments showed that under these conditions the sucrose is hydrolyzed and the solution becomes slightly acid. A control experiment showed that the speed of the hydrolysis due to the temperature (79°C.) to which the solutions were heated by the lamp is very slow compared with that due to the action of the ultra-violet rays. The quantity of sucrose hydrolyzed is nearly as great in a 10 per cent. solution as in one of double this concentration. The rate of hydrolysis increases with the duration of the exposure, this being accounted for by the acid formed in the reaction. The formation of this acid depends on a catalyst which is present in traces in the solutions.

Bierry, Henri and *Ranc* (Comptes. rend., 1911, 152 1629) have investigated the action of ultra-violet rays from a quartz mercury vapor lamp on 5 per cent. solutions of *sucrose* at 40°C. in vacuo and 20°C. in presence of air, with and without addition of calcium carbonate. It is found that under the influence of the ultra-violet light the sucrose is hydrolyzed to an extent which is quite appreciable after 20 hours' exposure at 40°C., while if the solution is exposed for 48 hours at this temperature it is found to contain formaldehyde. In absence of calcium carbonate gas is liberated, but this is a secondary phenomenon. The gas is scarcely perceptible before 72 hours and becomes marked on the fifth or sixth day of exposure at 40°C. Of the combustible part of this gas 50 per cent. consists of carbon monoxide.

Action on Water Virtually Electrolysis.

Tian (Comptes rend., 1911, 152, 1012) states that when *water* is submitted to the action of ultra-violet rays it is decomposed into hydrogen and hydrogen peroxide; the latter, in turn, is decomposed and oxygen is liberated, the ultimate effect of the action of the rays on water being identical with that of electrolysis. The volume of the gases liberated diminished gradually—namely, from 25 cubic millimeters per hour at the commencement of the experiment to 3 cubic millimeters per hour. The gas contains only about 1 per cent. of oxygen during the first half hour; the proportion of oxygen then increased. This appears to be due to the fact that hydrogen peroxide is first formed, and only when this begins to be decomposed is oxygen evolved. When the quantity of hydrogen peroxide becomes constant (i. e., when the amount formed is equal to that which is decomposed) the liberated gas contains two volumes of hydrogen to one volume of oxygen. The decrease in the volume of the gas after a time may be due to the action of the hydrogen upon the oxygen, which has been found to take place under the influence of ultra violet rays.

The coefficient of absorption (Comptes. rend., 1911, 152, 1483) in water of the part of the light which effects this action is a constant. Hence this part of the light must consist of a single ray or of a group of rays of nearly equal wave lengths. The curve of absorption of light in water shows that these rays must have wave lengths of about 1,850 angstrom units (1 angstrom unit equals $1 \times 10 = 7$ m.m.)

Mercury Spectrum Confirms Conclusion.

In the confirmation of this *Tian* finds that the mercury spectrum contains a group of rays of wave lengths 1,846, 1,848 and 1,851 angstrom units. This spectrum also contains rays of wave lengths 1,941, 1,971 and 2,000 units. In view of the wide interval separating this group from the former and the considerable variation of the spectrum it is concluded that the decomposition of *water* is effected by the former group only, at least under the conditions of the experiments (a statum of air 5-6 c. m. thick and a plate of quartz 1 m.m. thick separated the light from the water). This view is borne out by the fact that no rays of shorter wave length than 1,846 angstrom units were found in the mercury spectrum, though the absence of such rays was not absolutely proved. The light emitted by the spark discharge between aluminum electrodes contains rays of wave lengths 1,854, 1,857.5 and 1,862 angstrom units, and also decomposes water with the formation of hydrogen and hydrogen peroxide.

From experiments on the action of ultra-violet rays on water, concludes *Kernbaum* (Farm. Polsk., 16, 71-2, 1913) that *water* must undergo decomposition. Experiments indicate that the sun rays will act on water in the same way. Distilled water free from air was put in a quartz vessel and connected with a mercury manometer and then exposed to the action of sun rays. Evolution of gas was registered after a few hours. Using Shonbein's reagent, hydrogen peroxide was detected according to the equation $2H_2O = H_2O_2$. The quantity of it is larger when the experiments are carried out in presence of air, as was shown by the blue tint of the fluid in a quartz vessel.

(To be continued in the April issue.)

POTASH PRODUCTION IN 1916 INCREASES TENFOLD

U. S. Geological Survey Estimate Indicates Production of Nearly 10,000 Tons K_2O, With Prospect of Much Greater Yield Next Year.

Statistics of the production of potash in the United States in 1916 are nearly complete, only a few of the important known producers having failed to report to the United States Geological Survey, Department of the Interior. The following preliminary estimate is believed to be approximately correct. Complete figures will be published later, when all the returns have been received.

The total production of potash salts and potash products in the United States in 1916 was close to 10,000 tons of potash (K_2O), with a net value at point of shipment of at least $3,500,000, figured at the prevailing selling prices. This is ten times the value of the production reported for 1915, but the figures submitted by many of the producers represent only a start made toward the end of 1916. The total for 1917 is therefore likely to be much greater.

The production reported to date for 1916 may be summarized as follows:

	Available K_2O (short tons).	
Mineral sources:		
Natural salts or brines..........	3,850	
Alunite and silicate rocks, including furnace dust recoveries....	1,900	
		5,750
Organic sources:		
Kelp	1,110	
Pearlash (mostly from hardwood ashes); only 23 producers have reported to date out of a list of 70 establishments said to be producing	220	
Miscellaneous industrial wastes..	1,750	
		3,080
Total production....................		8,830

The largest output has come from the Nebraska alkali lakes, but the natural saline deposits elsewhere are now just beginning to make important contributions. The figures for potash derived from alunite, of which there is only one important producer, are combined with those for available potash in cement-kiln, flue-dust, greensand, and feldspar recoveries, in order not to disclose figures given in confidence. These do not include a considerable quantity of feldspar said to have been mined and prepared for possible use for the sake of the potash it contains.

Graphite Products Increases Stock.

The Graphite Products Corporation, of Saratoga Spa, has announced an increase in its capital stock from $30,000 to $150,000.

THE COLORIMETRIC TEST

for

The Determination of Organic Impurities in Sands

by

Prof. Duff A. Abrams and Oscar E. Harder*

The Danger from Organic Impurities in Sands Intended for Use in Mortar and Concrete Led the American Society for Testing Materials to Finance an Investigation to Develop a Reliable Test—A Report on Experiments Carried on at the Lewis Institute to Date, Which Seems to Favor the Abandonment of the Combustion Method and the Loss-on-Ignition Method, and the Adoption of Colorimetry, Is Here Given.

INTRODUCTION.

During the past few years the subject of impurities in sands for mortar and concrete has been receiving rapidly increasing attention from testing engineers and inspectors. Experience has shown that on account of the presence of impurities certain natural sands do not give satisfactory results when used in concrete, and many failures and much inferior work have been attributed to impurities in the fine aggregate. However, when it comes to determining before the sand is used in construction or subjected to tests in mortar, whether or not the sand is suitable for fine aggregate, there has been no well-established criterion regarding the impurities. Practically all specifications have required that the sand be clean; the so-called dirty sands have generally been in bad repute. Organic matter has been the principal source of trouble, yet many publications stating that as much as 10 per cent. of loam in sand was not harmful and might even increase the strength of the mortar, are to be found in the engineering journals.

An investigation initiated by Committee C-9 on Concrete and Concrete Aggregates, of the American Society for Testing Materials, showed the desirability of a simple and reliable test which would make it possible to detect sands which contained harmful impurities before they were used in concrete. Commercially, it was also desirable to develop some remedial measure which would make it possible to use sands which in their present condition, on account of impurities, are not satisfactory for concrete.

Disadvantages of Other Methods.

Engineers and chemists have recognized the danger of using sands which contained appreciable amounts of organic matter which may come from surface loam or other sources of contamination, and have used various methods for detecting such impurities. A method which has probably been most used depends upon the loss on ignition. Obviously the loss-on-ignition test drives off, besides the organic matter, the water of crystallization, hydration, etc., and the carbon dioxide (CO_2). In certain "limestone sands" the loss on ignition due to carbon dioxide alone may amount to more than 10 per cent., and yet the sand may be entirely free from organic matter. The determination of the organic matter by combustion has little advantage over the loss-on-ignition method, unless a correction may be made for the carbonates present. Methods which depend upon the moist oxidation of the organic matter have some advantage, but are not entirely satisfactory. None of these methods determines directly the amount of organic matter in the sands. Most of them determine the amount of carbon by first converting it into carbon dioxide. The organic matter is then calculated by multiplying the per cent. of carbon by some factor, the accuracy of which is often questionable.

Limitations of Colorimetric Test.

The colorimetric test for organic impurities in sands represents one phase of the work which has been done at the Structural Materials Research Laboratory, Lewis Institute, Chicago, under the direction of the committee mentioned above. The fact that the sand has passed the colorimetric test does not in itself prove that the sand is suitable for mortar or concrete, since its fineness and other characteristics must also be considered as they affect the strength. The result of the researches, however, indicate that it is a reliable test for organic impurities, which are the most common source of danger in a sand of satisfactory granulometric composition.

It it is intended at this time to give only a description of the methods of making the test so that it may be tried out further in commercial and private laboratories. The experimental data obtained in the course of these studies will furnish the subject matter of a subsequent report.

It will be of assistance to the committee having this investigation in charge, if other experimenters will report the details of their tests and observations to the chairman, Mr. Sanford E. Thompson, 136 Federal street, Boston, Mass., or to the authors.

The colorimetric test may be described briefly as follows:

---

*Structural materials Research Laboratory, Lewis Institute, Chicago. Experimental work carried out in co-operation with Committee C-9 on Concrete and Concrete Aggregates, of the American Society for Testing Materials. Published by permission.

A sample of sand is digested at ordinary temperature in a solution of sodium hydroxide (NaOH). If the sand contains certain organic materials, thought to be largely of a humus nature, the filtered solution resulting from this treatment will be found to be of a color ranging from light yellow up through the reds to that which appears almost black. The depth of color has been found to furnish a measure of the effect of the impurities on the strength of mortars made from such sands. The depth of color may be measured by comparison with proper color standards.

Two methods of procedure have been developed: (1) For field tests; (2) for laboratory tests.

METHODS FOR FIELD TESTS.

Fill a 12-oz. graduated prescription bottle to the 4½-oz. mark with the sand to be tested. Add a 3 per cent. solution of sodium hydroxide until the volume of the sand and solution, after shaking, amounts to 7 oz. Shake thoroughly and let stand over night. Observe the color of the clear supernatant liquid.

In approximate field tests it is not necessary to make comparison with color standards. If the clear supernatant liquid is colorless, or has a light yellow color, the sand may be considered satisfactory so far as organic impurities are concerned. On the other hand, if a dark-colored solution, ranging from dark reds to black, is obtained the sand should be rejected or used only after it has been subjected to the usual mortar strength tests.

Their Uses.

Field tests made in this way are not expected to give quantitative results, but will be found useful in:

(1) Prospecting for sand supplies;

(2) Checking the quality of sand received on the job;

(3) Preliminary exmaination of sands in the laboratory.

An approximate volumetric determination of the silt in sand can be made by measuring or estimating the thickness of the layer of fine material which settles on top of the sand. The per cent. of silt by volume has been found to vary from 1 to 2 times the per cent. by weight.

METHOD FOR LABORATORY TESTS.

To a 200-gram sample of dry sand add 100 c.c. of a 3 per cent. solution of sodium hydroxide (NaOH) and digest at ordinary temperature, with occasional stirring, for 24 hours. Filter this solution through a good grade of filter paper; refilter if necessary. The filtrate *must* be clear. Place 10 c.c. of the *clear* filtrate in a 50 c.c. Nessler cylinder and dilute to 50 c.c. with distilled water. Shake thoroughly and let stand until all foam and bubbles disappear. Determine the color value of this cylinder by comparing it with cylinders containing standard solutions of alkaline sodium tannate. Compare the colors by looking through the full depth of the solution with the cylinders held toward a good natural light.

Standard Tannic Acid Solution.

The preparation of the standard tannic acid solution for comparing the color of the filtrate should be begun at the same time as the treatment of the sand. Add 10 c.c. of a 2 per cent. solution of tannic acid in 10 per cent. alcohol to 90 c.c. of a 3 per cent. solution of sodium hydroxide. The sodium hydroxide combines with the tannic acid to form sodium tannate. Let the solution stand 24 hours at room temperature. Place 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 c.c., respectively of this solution in 50 c.c. Nessler cylinders and dilute to the mark with distilled water. The amounts of tannic acid in the different cylinders will then be as shown in the following table:

Alkaline Sodium Tannate in each cylinder—cc. ...	1	2	3	4	5	6	7	8	9	10
Tannic acid in each cylinder—milligrams	2	4	6	8	10	12	14	16	18	20
Color value in parts of tannic acid per million of sand by weight	100	200	300	400	500	600	700	800	900	1000

It is desirable to have good sunlight for comparing the colors; if sunlight is not available, the amount of tannic acid in each of the cylinders containing the standard solutions may be decreased by one-half and the other values in the table modified accordingly.

In case the solution obtained by digesting the sand with the sodium hydroxide is very dark, use less than 10 c.c. for the comparison and make the necessary modifications in the calculation of the color values. With very light-colored solutions use more than 10 c.c. of the filtrate for the comparisons. The depth of color of the solution decreases on standing, and for that reason the solution should be made up fresh for each day's work.

Calculating Color Values.

Method of Calculation. An example will make clear the method of calculating the color value of a sand. Suppose that 10 c.c. of clear filtrate obtained by digesting the sand with 100 c.c. of a 3 per cent. solution of sodium hydroxide when diluted to 50 c.c. corresponds in color to the Nessler cylinder containing 12 milligrams of tannic acid, or 6 c.c. of the alkaline tannate solution. The sand will then have a color value of 600. The 10 c.c. of the filtrate placed in the Nessler cylinder is 1/10 of the 100 c.c. of 3 per cent. sodium hydroxide solution which was added to the sand, and the sample of sand (200 grams) is 1/5 of a kilogram; therefore, the milligrams of the tannic acid per kilogram of the sand, by weight, are $12 \times 10 \times 5 = 600$; or the tannic acid equivalent when expressed in parts per million of the sand, by weight, is 600.

Basis of Colorimetric Test.

The colorimetric test has been applied to sands from about 40 widely distributed deposits in 20 different states. The research to date has brought out the following:

1. Examinations of deposits of defective sands show

that surface loam is the principal source of contamination.

2. All natural sands which have been found to be defective on account of the presence of organic impurities have responded to the colorimetric test with sodium hydroxide, and all sands which have given high color values have shown low values in mortar tests.

3. Sands which were similarly graded by screening out and recombing the different sizes to a definite sieve analysis showed a fairly definite relation between the compressive strengths of 1-3 mortars at 7 and 28 days and the color values of the sands.

4. The mortar-making quality of sands known to contain organic impurities has been much improved by removing the organic matter, either by repeatedly digesting them with sodium hydroxide and then washing free from alkali, or by driving off the organic impurities by ignition.

5. When the sodium hydroxide extracts from sands which mortar tests had shown to be defective were purified and applied as coatings on high-grade sand, that sand was made "defective" or gave much reduced mortar strength.

6. It is impracticable to give exact values for the relation between the color value of a sand and the strength of mortars made from the same sand. However, the tests made thus far show this relation to be about as follows:

Color Values of Sand	Reduction in Compressive Strength of 1/3 Mortar Per Cent
250	10-20
500	15-30
1000	20-40
2000	25-50
3000	30-60

The reduction in strength is based on compression tests at ages of 7 days, 28 days, and 3 months of 1/3 mortars made from the same sand before and after coating with different per cents. or organic impurities which had been extracted from defective sands and purified. Tests on mortars made from defective sands as received and after removal of the organic impurities, either by repeated extractions with sodium hydroxide or by ignition, showed that in some cases the reduction in strength for a given color value was even greater than the higher values given above. Frequently the test pieces completely disintegrated in the storage water. The higher reductions in strength for a given color value for a natural sand as compared with the same color value for an artificially coated sand is probably due to the artificial coating being more easily removed by sodium hydroxide.

Sufficient data are not available to indicate whether or not the effect of a given quantity of organic impurities varies with the grading of the sand. The reduction in strength seems to decrease slightly with the age of the test pieces.

The apparatus required for making the colorimetric test of sands will vary according to the nature of the investigation.

The time actually required for a single determination by the laboratory method is about one-half hour. If tests on as many as five samples can be made at once the total time consumed need not exceed one hour. The time required from the beginning to the end of the test is about 24 hours.

Experience Not Necessary.

Inexperienced operators without technical training or previous experience in work of this character have secured satisfactory results at their first trials.

The strength test of mortar is used as the criterion of the effect of impurities in sand. In making strength tests of sand mortars and interpreting the results of such tests the following points require particular attention:

(a) Sampling of sand,
(b) Grading of sand,
(c) Quantity of water used in mixing,
(d) Methods of mixing, molding and testing,
(e) Form and size of test piece.

(a) Great care is necessary to insure that the sample tested is representative of the larger lot of sand. Good judgment and considerable experience are necessary to secure representative samples from an undeveloped deposit. Some form of sampler should be used in the laboratory in selecting a test sample from a larger lot.

(b) The size and grading has an important influence on the concrete and mortar-making qualities of sands. A sand graded from coarse to fine, with the coarse particles up to about one-quarter inch in diameter, is desirable for use in concrete. Fine sands when mixed to the same plasticity give mortar strengths much below those of coarse, well-graded sands. The influence of the grading of sand on the strength of the mortar must not be confused with the effect of impurities.

(c) The quantity of water used in mortar tests has just as important an influence on the strength as the amount of cement. The quantity of water required for normal consistency of mortar made from a given cement is a function of the grading of the sand.

(d) The methods used in mixing, molding the test pieces, storing and testing the specimens, etc., used in standard tests of cement should be followed in making strength tests of sand mortars.

(e) Compression tests of mortar are believed to be more significant than tension tests. A 2 by 4 inch cylinder has been found to give satisfactory results as a compression test piece. This is the form of test piece recommended by the American Society for Testing Materials in their proposed tentative specification for compression tests of cement.

The funds for this investigation were furnished by Committee C-9 on Concrete and Concrete Aggregates of the American Society for Testing Materials, Sanford E. Thompson, Boston, Mass., Chairman; F. W. Kelley, Albany, N. Y., Chairman of Sub-Committee V. on Impurities Affecting Fine Aggregates for Concrete.

CHEMICAL CONTROL IN THE LEATHER INDUSTRY

By David Quick Hammond.*

Wide Fields for Personal Research Leading to Improvements in Reactions Now Carried On in Tanning Processes, Are Herewith Pointed Out by Mr. Hammond in His Interesting Discussion of Past and Present Aspects of This Branch of Industrial Chemistry.

IN order that the relationship of chemistry to the leather industry may be made clear, it is necessary that a brief discussion of the processes of leather manufacture first be given. At best it is possible to deal only in generalities, for each tanner has his own individual ideas and formulae which are especially adapted to the class of hides with which he deals and the use to which the finished product is to be put. Perhaps it will not be altogether out of place to speak likewise of the cordial(?) relations which have, in the past, sometimes existed between the tanner and the chemist.

The average tanner has often been, heretofore, the most incredulous of business men, due no doubt to the very secrecy with which he has attempted to keep his methods from his competitors. Tanning is a purely chemical process, despite the fact that this industry has prospered for years without any attempt being made to "chemicalize" it. Leather has long been manufactured by rule-of-thumb methods, the tanner knowing that such and such a process would bring about such and such a result without fully understanding just *why* it did. Any new methods were always discovered by trial and elimination, not by theoretical knowledge.

In a chemical process such as the tanning of leather it is impossible for any process to be practical unless it is first possible from a theoretical chemical standpoint, although a process theoretically possible is not always practical. The tanner, because of his innate skepticism, formerly refused to believe in the value of an untried process just because it happened to be evolved by a reputable chemist. He demanded an ocular demonstration that the process could be accomplished successfully in a tannery as well as in the laboratory. And because such a demonstration necessitated the risking of his own capital on what, to him, probably looked like the roseate hope of an impractical theorist, the matter usually ended there. It has been only very recently that the chemist has become recognized as essential to the tanning industry.

Early Lack of Mutual Understanding.

Sixty-three years ago a German chemist published an article setting forth a new method for the tanning of leather, namely, by the use of potassium dichromate. At this time leather was being tanned only with barks and by methods not differing greatly from those employed by our aboriginal ancestors. It is therefore easy to see what an entirely new departure this was, but for all that, the article was given no credence, due in part, perhaps, to the fact that it was couched in purely theoretical chemical terms, and likewise because the chemist admitted freely that the process had not been tried in a practical way. This was followed shortly by another article written by an English chemist describing a process for a two-bath chrome tannage which was almost identical with the chrome processes now in use. Perhaps the article went unnoticed by the tanners of the day; more probably it was lacking in cold facts when considered from a practical standpoint, and was, therefore, looked upon as a dream. Suffice it to say that it was not until nearly forty years later that the method was tried by some progressive tanner, or perhaps rediscovered, and found to be entirely successful.

It is largely due to a few of the younger and more progressive tanners, and a few chemists who realized that what can be done in a test tube cannot always be done in a factory, that the chemist and the tanner are at last in full accord. These chemists worked out the tanners' problems at the factory in a practical manner and developed systems for the chemical control of the processes. Chemistry, however, is not yet so prevalent in our tanneries as in our steel plants, our rolling mills and our munition factories, because the application of chemical control to this industry is still in its infancy. Chemists have expended their energies in bringing about definite results, but for all that, the analysis of vegetable tanning materials and oils is still made merely on a comparative basis, and possible only by the efforts of the American Leather Chemists' Association in standardizing the methods to be used.

Tanning Methods in General Use.

Let us turn, then, to the actual methods employed. Tanning is a process which changes a perishable, putrefying hide or skin into a stable, non-putrefying article known as leather. The hide, which is in a green, salted or dried condition, as the case may be (not taking into consideration the pickled skins from Australia, etc.), must first be brought back as nearly as possible to the condition it was in directly after being removed from the animal. This is accomplished by soaking it in water for from three to five days in the case of green hides and longer in the case of the dry. The soaking should also remove all dirt, filth and salt, because their presence would interfere with a uniform action of the lime, which is applied later. Unless completely removed, the salt leaves a so-called "salt-stain" after coming in contact with the lime, and this stain could not thereafter be removed throughout the entire process.

---

*Leather Chemist, 27 Putnam St., Tunkhannock, Pa.

The object of "liming," or placing the hides in vats filled with water and suspended $Ca(OH)_2$, is to eat away the outer skin surrounding the hair sacs, so that the hair may easily be removed by scraping, and to swell or "plump" the fibers of the hide so that they will be open to receive the tanning material. The liming is accomplished in four or five days, 8 pounds of lime being used for every 100 pounds of hides. After the hair and flesh have been removed, the lime itself, if what is known as the "acid" process, where the tannin enters the hide in the presence of a strongly acid solution, is being employed, must also be removed, for strong acid on a hide containing lime will cause brittleness.

Action of the Bate.

The lime is removed by "bateing" with hen or dog manure and wheat bran, which carries, or produces, a species of bacteria which destroy the lime. The power of these bacteria ceases automatically when all the lime has been removed, but immediately another species of bacteria, which are inactive in the presence of lime, now become active in its absence and begin to destroy the hide substance. At this point the bate must be quickly removed from the hides. There is a patent bate known as "Oropon," which is used very successfully, as it contains only the bacteria which destroy the lime, and therefore can be used without danger of any loss of hide substance. Hides which are to be tanned with a tanning solution which is only mildly acid, however, need not be bated at all, if as much of the lime as possible is first removed by washing and drumming with water.

Bateing depletes the hides, and they must again be plumped in order that the fibers may be open to receive the tanning material. This is accomplished by pickling the hides in a solution of one part by weight of concentrated 66° H_2SO_4 to 8 parts by weight of NaCl.

Reactions of Two Classes of Tannage.

The hides are now ready for the tanning material, which may be divided into two classes, vegetable and mineral tannage. Tannin, which belongs to the former class, is to be found in numerous vegetable growths such as the barks of oak, hemlock and chestnut trees, and in various plants, nuts, pods, etc., of tropical and semi-tropical varieties. Perhaps tannin is to be found most abundantly in the roots of the palmetto tree, from which source it is obtained in larger and larger percentages as we approach the equator. The tannin is leached or percolated out with water in the presence of heat and placed in contact with the hides in varying strength, according to the process used. Combination of the tannic acid with the constituents of the corium is effected, and the hide is thereby rendered tougher, less permeable and nonputrescible.

Mineral tannage consists chiefly of chrome tanning, which is accomplished by milling the hides with the solution of a mixture of potassium dicromate, HCl and NaCl, and later with sodium thiosulphate, which acts as a reducing agent and effects the precipitation of Cr_2O_3 between the fibers of the hide. This completes the tanning process, and it remains only to "finish" the leather in any manner desired.

I have given this very general description, not with the idea of presenting a detailed exposition of the actual manufacture of leather, but in order to be able to point out clearly just where the possibilities for personal research lie in the leather industry.

Wide Field for Original Research.

Quite naturally, we turn first to chemical control. The "soaks," where the hides are soaked in water to be cleansed before entering the "limes," use running water. What kind of water brings about the desired effect most efficiently? Instantly we encounter a wide dissociation of opinion, for one tanner will say hard water; another, medium, while still another—if you can make him talk—will tell you that he has been most successful with soft water.

Next we may consider the action of the lime on the hide substance, which, of course, is composed chiefly of gelatine. How does it act? We know that it acts on the hide with the formation of ammonia; that the vigor of the reaction increases as the temperature rises, and that the formation of additional ammonia also hastens the reaction. The crude lime to be employed should be analyzed for the presence of available CaO, it being the lime in solution, of course, which acts on the hide. Although lime is less soluble in hot water than it is in cold, it is perpectly natural that the increase in the speed of the reaction attendant upon a rise in temperature should more than overbalance the loss in strength of the saturated solution of lime. The contents of the lime vats should be analyzed for the presence of ammonia, which is a check on the loss of hide substance.

In connection with the hair, which is recovered and sold as a by-product, let me say that the chemist who discovers a cheap practical method for bleaching dark hair pure white, will make a fortune, for the white hair sells for seventeen cents per pound more than the dark hair. The "fleshings," from which the oil is extracted, are sold as "glue-stock," from which gelatine is made. There is ample opportunity for research here. In the matter of bate, the inventor of "Oropon" has a pretty clear field at present, but improvements will be made, no doubt, in this field also.

Both Methods Need Acurate Control.

The control of the chrome tanning process is plain analytical chemistry, although a seemingly simple analysis often produces great difficulty, for chromium is a highly refractory metal to analyze when in the presence of other minerals found in tanning liquors. In a majority of cases I have found it best to employ the volumetric method, using potassium iodide, starch paste and sodium thiosulphate, after first "popping" with sodium peroxide and neutralizing with hydrochloric acid. It is sometimes necessary to precipitate the chromium as the hydroxide with ammonia, after destroying the organic matter present with aqua regia, but often it is impossible to feel in any way certain as to the accuracy of the result because of the organic matter. Some very useful research would not be out of place with regard to this analysis, as the necessity of accurate chemical control at this point in the tanning process needs no emphasis on my part.

It is, however, the vegetable tannins which offer the widest field for research. New tanning materials are being put upon the market constantly. The chemistry of the vegetable tannin is but little understood, for its analysis is based on the amount taken out by treatment with hide powder. The analysis referred to is a comparative rather than an accurate one, much as is the case with a coal analysis, and the final result is merely a more or less accurate comparison. I believe that a far more accurate analysis is possible, and that such a one will eventually be developed. The absolute necessity of chemical control of these tanning liquors is self-evident from an efficiency standpoint alone. There are control processes now in use, but they are far from having attained an ideal state, and I believe every tannery chemist will agree that there is great room for improvement.

Oil Analysis Not True Guide to Tanner.

Sulphonated cod oil, menhaden and mineral oils are used extensively in the tanning industry. The tanner demands various chemical specifications for the oils which he uses, but not, mark you, because the *combination* of properties written on the analysis card indicates to him the suitability of a given oil to his particular needs, but merely because he has at some time successfully used an oil having a certain property, *among the other properties listed*. Thenceforth he has associated the presence of this single property in an oil with his success, and would in future reject another oil having a *combination* of properties far better suited, perhaps, to his needs in favor of any oil whose analysis card indicated its presence. The oil analysis in general use for tanning oils is, therefore, something of a farce so far as acting as a guide in the tanner's selection of an oil is concerned; it means little to the tanner himself. There is great need for an oil analysis which will give a ratio, or some definite grading of characteristics which would show the true values of oils in their application to various kinds of leather.

Some of the larger leather concerns maintain extensive laboratories, but naturally they are not publishing the results of their costly researches. In the encouragement of her industrial chemists, America is only beginning now to do what Germany has been doing for years.

Awakened to the fact that many of them were confronting a serious predicament as a result of the war, American manufacturers bestirred themselves, looked the situation over, and then demanded petulantly why American chemists could not produce for them the dyestuffs, intermediates and a host of other materials which were obtained formerly from Germany. And the answer is: They can—if they receive in future the moral and financial backing which the German chemists have always received.

Wanted—More Faith in the Chemist.

It is a historical fact that the Badisch Dye Company, in Germany, spent *ten years* and *twenty millions of dollars* in practical research work before a single pound of dye was placed on the market. Would any group of American business men have sufficient faith in the American chemist to risk so much capital without being certain of the returns? Or assuming that they *were* absolutely certain of adequate returns, would American business men be content to wait so long for those returns? Most assuredly not, particularly in the past, and for this reason the American industrial chemist has thus far been outstripped by his German brother. For the future no one can answer, but there is every reason to hope for better co-operation, now that the further possibilities have been brought squarely before our financiers.

The Chemist, Too, Can Help.

And the industrial chemists themselves have not been wholly without blame for the existing state of affairs. They must learn to school themselves still more to the idea that a new process successfully carried out in the laboratory is only half completed until they have also devised a method to demonstrate conclusively its adaptability to actual manufacturing conditions. They must learn to become, if not actually business men themselves, at least able to translate the results of their activities into business terms. American chemists are progressing rapidly along this line, and there is no doubt but that the approaching financial backing of some of our larger corporations will soon bring the American chemist second to none.

SYNTHETIC INDIGO IN U. S.

A new departure marking an important step in American coal tar color manufacture was achieved by the Dow Chemical Company, of Midland, Mich., when it began recently the production of synthetic indigo. The daily output of the plant is said to be about 5,000 pounds of 20 per cent. paste. Since the outbreak of the war the sole synthetic indigo to reach this country has been from a single plant in Basle, Switzerland.

New Pharmaceutical Company.

Under the laws of New Jersey the Glyzine Company, pharmaceuticals, of 870 Broad street, Newark, has been incorporated with a capital stock of $25,000.

CRYSTALLIZATION OF CREAM OF TARTAR IN THE FRUIT OF GRAPES

By William B. Alwood.[*]

Experiments Carried on at U. S. Enological Laboratory Reveal the Natural Deposition of Patassium Bitartrate During the Ripening Process.

During the chemical examinations made of the ripening of grapes in the Enological Laboratory, Charlottesville, Va., the writer was led to conclude that the acid salt bitartrate of potassium was deposited from the juice in quantity sufficient to sensibly affect the analytical results. This led to the preparation of samples by the complete exhaustion of the soluble constituents of the berries, with results which supported the above conclusion.

The question of the character and location of the crystals of cream of tartar in the berry presented itself as a matter of interest and possibly of practical importance. The literature available did not furnish specific information on this point. Babo and Mach, in their exhaustive treatise, give but one brief reference to the occurence of this salt in crystals in the fruit.

As soon as the fruit was well colored at Charlottesville in 1912 a series of microscopic examinations was undertaken to determine whether crystals of bitartrate of potassium occurred in the fruit. Portions of Concord grapes were prepared and examined daily until the fruit was ripe. Minute crystals varying much in shape and size were found in great abundance in the soft cells lying just beneath the skin of the fruit. Crystals were not present at any time in the pulp or compact portion of the flesh in which the seeds are contained. Like examinations of Concord and Catawba were carried on at Sandusky, Ohio, in September and October, 1912, and crystals of the same general type were found.

The fact that many of the crystals found in the berries did not conform in type to crystals of the bitartrate prepared from pure cream of tartar made it doubtful as to whether potassium bitartrate was deposited or not. Therefore, the fruit was separated into portions for the purpose of a chemical examination covering this point. The tough pulp containing the seeds of 1,500 grams of ripe berries was separated from the hulls and soft peripheral layer of cells which adhere to the hulls. This layer contains the coloring matter. The hulls and pulp were then carefully pressed by hand and the juice of each recovered and held separately. This gave three portions: (1) The pressed hulls, (2) the juice recovered from the hulls, and (3) the juice recovered from the pulp.

In preparing the sample, all the juice possible was recovered from the sample of hulls and pulp; that is, they were entirely exhausted so far as crushing and pressing could accomplish this result. The pressed hulls were then carefully macerated in distilled water until the soluble organic matter was exhausted. These portions showed on analysis the results given in Table I.

TABLE I.

Analyses of Concord grapes in 1912, giving the percentage by weight of acids and acid salts.

Portion analyzed.	Total acid.	Total tartaric acid.	Free tartaric acid.	Cream of tartar.
Hulls exhausted with water.	0.429	*0.589	0.08	0.56
Juice pressed from hulls.....	.141	.054	.00	.07
Juice pressed from pulp.....	1.065	.724	.20	.59

*The results show for the samples of "hulls" a greater content of tartaric acid than the total titratable acid of the samples. This is always the case in grape samples where the "acids other than tartaric" fall below a certain proportion.

The results show that the juice pressed from the hulls is very low in acid and acid salts, and that, while the organic matter remaining in the hulls after pressure is less than half as acid as the pulp, it is rich in tartaric acid and cream of tartar, in these regards nearly equaling the percentage found in the juicy pulp. The actual weight of the pressed hulls was 304 grams, or one-fifth of the original sample of fruit. From the results given, it would appear that the hulls when pressed dry still retained the crystals observed with the microscope, and actual observation has demonstrated this fact. The results for tartaric acid and cream of tartar settle the point as to the composition of these crystals.

In 1913 the microscopic examinations were begun much earlier, and four varieties of grapes were included—Delaware, Concord, Niagara and Norton. The presence of crystals of bitartrate of potassium could be observed before the berries were all colored, and the analyses of partly ripe fruit confirm the results of 1912. These samples were separated into two portions only, the hulls and the pulp, as noted above; then each sample was completely exhausted of soluble organic matter by repeated macerations and heating in distilled water. Table II gives the results for one set of samples from each of two varieties.

TABLE II.

Analyses of grapes in 1913, giving percentage by weight of acids and acid salts.

Portion analyzed.	Total acid.	Total tartaric acid.	Free tartaric acid.	Cream of tartar.
Concord.				
Hulls	0.95	*1.11	.00	1.33
Pulp	1.43	.79	.04	.82
Niagara.				
Hulls	0.67	*0.93	.00	1.18
Pulp	.96	.83	.18	.57

*The results show for the samples of "hulls" a greater content of tartaric acid than the total titratable acid of the samples. This is always the case in grape samples where the "acids other than tartaric" fall below a certain proportion.

There are crystals other than bitartrate present in the fruit, but this paper is intended only to record an observation which may have peculiar interest. Further details of the investigation will appear later.

---

[*] Chief, Enological Laboratory, Bureau of Chemistry. From the Journal of Agricultural Research, U. S. Department of Agriculture.

IMPROVEMENTS IN WASTE DISPOSAL PLANTS

By Gustave R. Tuska, M. S. C. E.*

GUSTAVE R. TUSKA.
Copyright, Underwood & Underwood, New York.

Although Costing Considerably More for Fuel and Solvent Than a Plant Operated on the Digester System, the Process Here Dealt With Obviates All Odors and Losses Due to Carbonization, and Greatly Increases the Recovery of Ammonia and Potash.

THE growing public interest in the general recovery of by-products heretofore wasted, and in the effort to avoid the destruction of any useful materials, has been especially evident in the discussion of the disposal of municipal waste. This interest has naturally been extended not only to the processes and methods used in the disposal of such wastes, but also to the matter of the ownership of such plants, and whether they are to be municipally or privately operated.

From the standpoint of the public, however, every consideration in the design and construction of such plants should be subordinated to the question of their being built and operated according to the most sanitary methods. The first cost of the plant and its cost of operation should only be considered after the question of sanitation.

The municipal wastes above referred to consist of ashes, rubbish and garbage.

In the matter of the handling of the ashes and rubbish there have been no marked improvements during the last few years. "Filling in" with the ashes and incineration of the rubbish still continue to be the best methods when these materials are handled separately. When they are disposed of in combination with the garbage, high temperature destructors are used. Except in the matter of some of the details of the design and operation of these destructors there have been no important improvements made during the last few years.

Two Methods of Garbage Disposal.

As to the disposal of the garbage of large municipalities, two methods in the main are used. First, disposal in the high temperature destructor furnaces referred to above, and second, disposal by reduction processes, in the course of which there are recovered from the garbage grease and low grade ammoniates, both of which materials are of considerable commercial value. It is in the methods of reduction for the handling of garbage that the greatest improvements have been made in the last few years. Formerly, where successful reduction processes were used, they were only of two types—one, where the garbage was mechanically dried in hot-air furnaces and the grease then extracted by means of a chemical solvent and the material then redried so as to produce a commercial product, and second, where the garbage was digested, pressed and mechanically dried, the grease being extracted partly by pressing and partly by degreasing with chemical solvents.

These processes have been in use in all large American cities where reduction of garbage has been followed and in almost every case strong objections have been raised to the operation of such plants on account of the nuisances created. The main objections to these plants have arisen from the gases produced in the destruction of the garbage and from the gases discharged in the drying processes used in these plants.

A New Process.

To obviate these objections a new reduction process has lately been evolved. The operation of this process is as follows:

The raw garbage is placed in a closed tank which is sealed air tight. This tank or reducer is constructed with jacketed walls and jacketed bottom. Into these jackets the steam which is used in the reduction of the garbage is delivered, these jackets being so designed that it is impossible under proper operation for the steam to enter the tank or come in contact with the garbage. In the interior of this tank there is an agitating device operated by power from the exterior. When the proper charge of garbage has been placed in the reducer and the covers placed thereon the tanks are sealed and the solvent is pumped into the reducer and steam admitted to the jacketed walls. The heat from the steam which is transmitted to the garbage through the walls of the reducer causes the evaporation of the solvent and the water in the garbage.

Garbage is usually composed of over seventy-five per cent. by weight of water. The steam heat vaporizes the solvent and the water from the garbage, and these mixed vapors are drawn off from the reducer to the condenser. The economy in this method of evaporation rests on the fact that water is vaporized at a lower temperature when evaporated with a solvent having a low boiling point than when evaporated without such solvent.

Solvent Retained for Further Use.

The mixed vapors of the solvent and the water while in the condenser are there condensed to a liquid state and the water and solvent together are conveyed to a closed tank. Owing to the solvent being of lighter specific gravity than the water, the solvent and the water are separated by gravity, the solvent rising to the top, from where it is drawn back to the storage tanks, from which it is pumped back to the reducers and used over and over again. The condensed water, which has been largely diluted owing to the jet condensers used, is discharged into sewers or waterways.

---

*Lecturer on Municipal Waste Disposal at Columbia University. Consulting Engineer, 68 William St., New York City.

Paper read at Section D, Engineering, of the American Association for the Advancement of Science, December, 1916.

When the garbage has been thoroughly dried by this method the solvent is pumped into the reducer and dissolves the grease. The solvent with the grease is drawn off into a closed tank or evaporator, where it is heated by steam pipes, the steam being kept separated from the grease. The solvent therein is vaporized and carried to a condenser, where it is again liquified and carried to the storage tanks to be used again.

After the grease has been extracted from the garbage in the reducer the latter is further dried by means of the steam in the jacketed walls and is now in the form of de-greased garbage tankage, which is used for fertilizer purposes after being ground and screened.

It will be seen from the above description of the process that if there are any leakages or vents in any of the tanks or piping where the solvent is handled more or less of the solvent is lost, and thereby a substantial additional expense is imposed upon the operation of the system. It is evident therefore that it is to the financial interest of the owner of the plant to see that the same is properly operated. Furthermore, under this system the garbage is at no time brought in contact with the atmosphere, from the time of its original entrance into the reducer until after over twelve hours of cooking; it is finally discharged therefrom as finished products, dried, sterile and practically odorless. These finished products are grease and the tankage above referred to.

Gases Kept in Solution.

It will be seen from the above description that the process is one of straight dehydration, and from the time that the material is at the boiling point no further chemical action in the material takes place. No process of "digestion" occurs, and therefore the odors and gases incidental to such a process are not created. Only the volume of gas contained in the raw material is driven out, and only the essential oils of an extremely volatile nature are carried over in the current of steam and solvent vapor evolved. That little or no conversion takes place in the operation is shown by the fact that in the dehydrated material obtained at the end of the operation there exists practically the same amount of unconverted starchy bodies as existed in the garbage at the time of its entrance into the reducer.

The water condensed contains all the gases evolved and has when fresh a slight odor of the mixed essential oils. Some traces of alcohol are detected in the effluent and a very small quantity of fixed oils is carried over. Any ammonia evolved, if it has escaped the acid in the garbage, is neutralized by acid carried over in the vapor. Whatever albuminoid ammonia exists in the effluent is carried over by mechanical entrainment as dust particles during the steaming out of the solvent.

The effluent from this process consists of almost pure water, this water being the condensed moisture drawn from the reducer while the garbage is being treated and from which the solvent has been extracted as completely as possible. The effluent is cold and gives forth no steam or vapor and is practically odorless, and as a result can have no undesirable effects when run into a large body of water.

Slight Odors Strictly Localized.

The only other possible source of odor during the entire reducing operation would be from the odor contained in the air and gases mechanically included in the green garbage prior to its entrance into the reducer. These gases, plus the air in the reducer itself at the time of filling, are driven out by the first rush of solvent vapor. The entire volume of such gases is so small that no objectionable condition can be created by their discharge.

As regards any odor from the tankage when this material is taken out from the reducer, it is in a dry condition and quite warm, and when it is first exposed to the atmosphere there is momentarily a slight odor of dried material, best described as a smell of stale gingerbread, due to the essential oils rising from the material when hot. No gases are generated, and this odor lasts only during the period of emptying of the reducer and is not offensive or perceptible outside the building.

It will be seen that in the operation of garbage treatment by this process there is no period of gas generation and no large volumes of decomposition and combustion gases given off as in digestion and drying. There is, therefore, no necessity for condensing, washing or trapping odors or gases.

A further improvement has also been made in the solvent employed in the de-greasing process. Heretofore gasoline has been used for this purpose, but it has been proved that a more economical operation and elimination of the danger of explosions is obtained by the use of a kerosene distillate, obtained by the treatment of ordinary kerosene in a vacuum still.

Increased Expense Justified.

The cost of a plant operating on the above system is from twenty-five to fifty per cent more expensive than one on the digester system. The cost of operation per ton of garbage by this system is also considerably higher than by the digester system, the labor cost being about the same, but the cost for fuel and solvent being considerably greater.

As against this increased cost, we have superior sanitary advantages and a considerably greater value of recovered products. By the use of this process a larger grease recovery is obtained, also a more valuable tankage. Where the digester system is employed the potash contained in the vegetable fiber, being soluble, is lost in the discharged water. With this process it remains in the tankage amounting to over 1 per cent by weight in the dried product.

Furthermore, with the digester system the largest portion of the water contained in the garbage is removed by pressing. This water, discharged from the presses, carries 8 per cent of solids by weight and is the most valuable for fertilizer purposes, as it contains all the ammonia and potash which is water soluble. All such material is recovered by this process. In addition, with the digester system where direct heat dryers are used there results a large loss of solids (tankage, grease and fibrous material), averaging about 20 per cent of the total weight of tankage fed into the dryer. This loss is due to carbonization of the materials named and results in various odors and gases. This loss with the resultant gases is avoided by this process.

CHEMISTRY AND ENGINEERING.

By Dr. Charles Carpenter.*

A Timely Message to the Industrial Chemist.

Lack of Mutual Respect for Each Other's Professions Between a Chemist and an Engineer Co-operating In the Erection of a Plant Frequently Spells Inefficiency and Waste, Declares the Writer—For the Benefit of Chemists He Here Describes the Training and Methods of the Engineer and Explains a Remedy Which Was Tried Successfully.

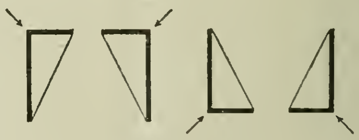
I PROPOSE to initiate a talk about chemists and engineers and their relationship to the great problems of bringing up to date our national chemical industries. The charter of the Institution of Civil Engineers defines the profession of the engineer as being the art of directing the great sources of power in Nature for the use and convenience of man. We might, in similar language, define the aim of the chemist as being to wrest from Nature some of her most hidden secrets for the same purpose. (I attach no importance to the definition of a chemist which describes him as an organic body more liable than any other of similar nature to spontaneous explosions.)

As I am talking to chemists, and not engineers, it will be best to begin at the beginning, even at the risk of seeming elementary. The popular conception of the engineer is that he is an empiric who has been trained on cotton waste and engine oil. This is, of course, a fallacy. He has just as scientific a foundation for his work as has the organic chemist, and, like him, has a *ring structure* from which spring his great creations. His ring, however, is centuries older and is basic in its simplicity. The diagram (Fig. 1) shows several such rings. Their form is a triangle with rigid sides and a flexible base. If force is applied to the apex, the ring is stable and resists distortion under the stress; in other words, it does the work for which it is designed. If force is applied to either of the two angles, it is seen to be unstable, and collapses.

Evolution of the Compound Ring.

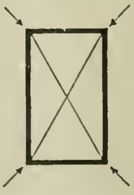
Two such rings may be joined together with a common base, and the two rings so coupled become a structure which has similar attributes to its components. If force be applied to either or both apexes, this double ring is stable; if to the opposite angles, it is unstable. But if the complete rings are combined to form a compound ring (Fig. 2) the structure becomes a stable one in all directions. The ring formation thus described is the basis of all construction and building in metals, from the framework of the Forth Bridge to that of a Zeppelin.

Let us now consider how the engineer sets out to achieve the task with which he has been intrusted. One of the necessary qualifications of an engineer is the possession of an imaginative faculty; he must see in his mind's eye the general outline of his finished production before it is designed in detail or its creation is begun. What will be his procedure if his work be the construction of, say, the former structure of the two examples just given? Drawings or maps would be useless to him without knowledge of the surrounding landscape itself. He goes then to seek inspiration on



Simple Ring Structures

FIG. I.



Compound Ring Structure.

FIG. 2.

---

*From the Journal of the Society of Chemical Industry. Paper presented at meeting of the London Section, London, England

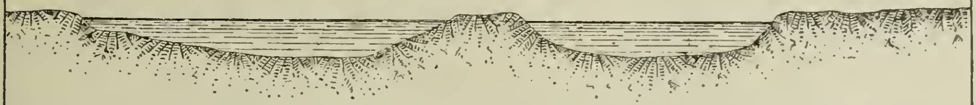


FIG. 3.

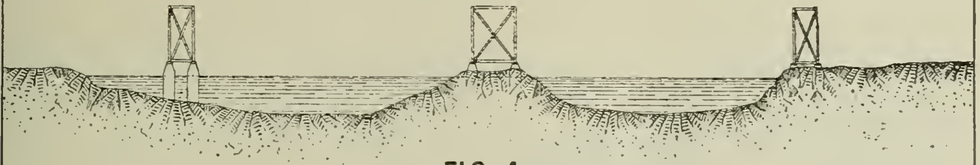


FIG. 4.

the spot just as a painter would to visualize and make studies for this picture. He watches the long slope of land stretching down to the river's edge from Fife on the one shore and from Linlithgow on the other, and realizes that what he builds must join those widely separated crests. He sees before him between midstream and the right bank the islet of Inchgarvie lifting its rocky head above the waters of the Forth.

Practical Application of the Ring.

Then begin his musings, and gradually the mists clear and the mental creation of his work begins. He dreams of setting up on the edge of the river a compound ring structure, placing another on Inchgarvie, and then as the expanse of stream beyond makes the width of span impossible, the idea comes to him of building for himself another islet in steel and artificial stone corresponding to Inchgarvie and reaching up from the river bed. At these three points he erects his massive compound rings, and from both sides of them he then proceeds to build out other rings, each balancing the other and growing smaller and smaller as they strech to meet each other across the waters below. He joins the gaps with smaller bridges until he makes the whole structure a continuous one from shore to shore. Observe the language of the engineer, Titan that he is. He has faith in himself, in his ability to master Nature, and he *throws* a bridge across what she made as a widely-parted chasm. The diagrams show the progress of the work. Fig. 3 represents a profile of the spot looking down stream in which Inchgarvie is prominent. The next diagram (Fig. 4) shows the artificial island he plants solidly upon the river's rocky bed on which his compound "rings" stand on feet or bases, and soaring upward for a height of 350 feet. These "rings" are drawn more in detail in Fig. 5, which clearly shows the building up of the structure from simple triangles. The sixth diagram shows the completion of the arms or cantilevers jutting widely out from the big ring, like the arms of some great monster seeking his mate. The seventh diagram gives a more general view of them before joining up, and the eighth figure shows the completed structure itself, more than a mile long and with a clear headway from high water mark of 150 feet, under which our great dreadnoughts can pass at will.

Former Status of the Engineer.

I want now to invite your consideration of the engineer from another point of view, and which bears a certain resemblance to the immediate necessities of our own industries. The picture on the screen (this was shown at the meeting) is from a drawing made between a half and three-quarters of a century ago. The vessel in the background is a first-class battleship, oak-built and wind propelled. The steamship is the Admiral's tender, and bears a name still honored in the Service. It is a picture of the beginning of the mighty Navy which now protects our shores, and which includes battle cruisers of such an enormous size that some of them consume fuel at the rate of an equivalent of over one thousand tons of coal per day. Imagine the mechanism of the appliances capable of first producing energy on such a scale down in the bottom of the ship's hold and then of utilizing it within her walls! No one could have any doubts as to the important part

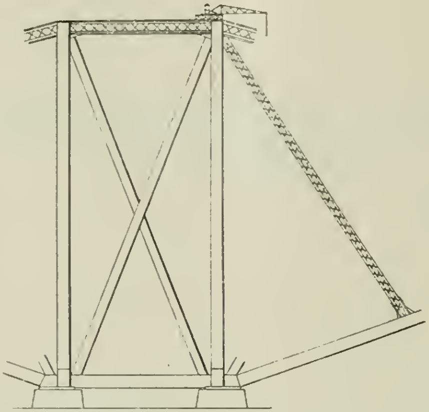


FIG. 5.

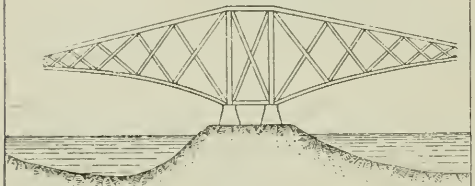


FIG. 6.

which must be played by the engineer in such an organization.

Now, from the earliest days of the application of steam to the Royal Navy until quite modern times its engineers were looked upon in the same, more or less, contemptuous fashion as they are, not infrequently, by chemists today. For many a day they messed apart from the ship's officers, whose butt for ridicule they often were. In recent years, however, one man great above his fellows set himself to remedy this state of things, which threatened seriously to menace the efficiency of the Navy and the safety of our Empire. That man is the present Lord Fisher, and I now want to tell you something of the work which he set himself to accomplish. With, I think, the thoroughness born of the Service to which from boyhood he was attached, he realized the importance of beginning life early, and instead of taking youths, who are more or less spoilt by the kind of training given them at the public schools, the entering age for a Naval cadet was made 13 years or a little more. At that age he is expected to satisfy his examiners in English, History, Geography, Arithmetic, Geometry, French or German, with some knowledge of Latin.

Engineers Selected Early in Life.

From that time his training begins in Physics, Chemistry, Applied Mechanics, Applied Electricity, and, above all, in Engineering and workshop practice. Until he is 17 years of age and goes to sea, that is the training of every officer in His Majesty's Navy. Whether he may be destined for a battleship commander, an engineer commander, or head of dockyard, the value of engineering in the making of a man is recognized from the commencement. There is, of course, a preliminary sorting out which is of great interest and importance.

Engineering in Chemical Industry.

Now it seems to me that the condition of affairs in Chemical Industry is very much akin to what has happened in the Navy, viz., that specialized engineering is becoming more and more necessary to it.

I had hoped to have been able to give you on the screen one or two pictures of a modern German-built chemical works, erected on British soil under the regulations of our Patent Laws, but forfeited to the Nation as a result of the war in which we are now engaged. It was considered, however, that this would disclose secrets of design and construction to which the Nation as a whole were not entitled. For my own part I consider that every single detail of the whole of these works should be drawn out and described for the benefit of the entire British Chemical Industry. I look upon this as an absolute right to which the Nation should be entitled. However, I have one or two other slides, very kindly lent to me by Dr. Harker, which will help to point the moral.*

The first is the power house at Saaheim. Next the Badische furnace at Rjukan. Next the interior of the furnace house in the new factory there. And the last the granite absorption towers. These are, of course parts of the nitrogen fixation plants. I give them as reminders that engineering design and construction is figuring more and more in modern chemical processes.

Now I believe it is increasingly necessary for the engineer to take a larger part not only in the design but in the running of this special kind of plant. I do not mean that the control should not be chemical, for I think in the majority of cases, if not all, it must be. But I am convinced that when the conditions are found and laid down, the engineer will be quite capable of carrying them out, while his natural ability for handling men and materials cannot but be most useful assets. For instance, it is quite an easy matter to lay down the conditions of working in, say, an autoclave or a centrifugal, and chemical control should be kept over such operations, but the practical working of the machines, their design and upkeep, and the regulation of the attendant labor, the design of the plant and its best lay-out, having regard to the general conditions of economy and the handling of materials, should in a large degree be left to the engineer, since by training he is the more practical person.

Let Engineer Execute Chemist's Plans.

If we start with the theory that everybody can be

---

*These slides were exhibited at the meeting.

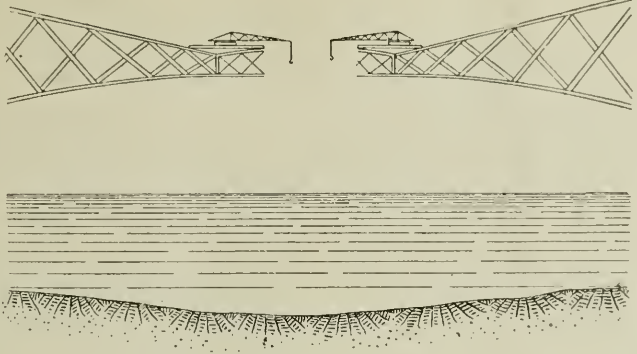


FIG 7.

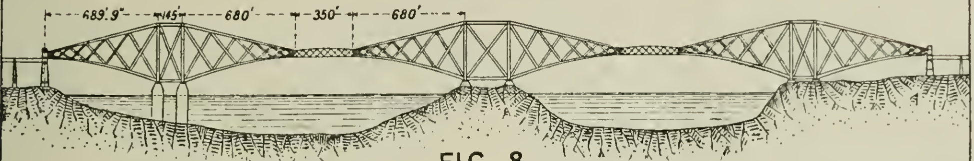


FIG. 8.

trained to be an engineer or a chemist we shall go hopelessly wrong. The function of our teachers should be to ascertain in what direction the mental capacity of each pupil lies, and to direct him to follow the right main road. It would be very easy to put forward a theory in respect of this if one were needed. In the branch of industry with which I am closely associated, I am aware that in the past there has been much lack of progress through the engineer not deciding to take the chemist into his counsel, but I am also sure of this, that had the chemist been substituted without on his part taking the engineer into his counsel we should have been no further forward. The case is essentially one for their working in harmony toward the common goal of perfection. I cannot but think, too, that British chemical industries have been to some extent partly sterilized by the narrow spirit in which some chemical manufacturers have regarded their operations. In my opinion, progress as a whole will be best achieved by them, not by hiding from everybody broad principles of design and working, but by placing reliance upon scientific knowledge and experience to keep themselves in the forefront of their competitors. The general principles of ship construction, of bridge making, and of engine building, to take one or two examples, are open practically to every apprentice engineer, who thus grows up in a general atmosphere of such employment which is of untold value to him if he has ability or opportunity to rise above his fellows and to specialize in any particular direction. And yet there are secrets in ship-building, in bridge-making, and in engine-designing, just as there are in the various chemical industries. The need of such men so trained is now becoming a national one and the full story of their serious shortage cannot yet be told.

Two Fields Separate, Yet Complementary.

If we are to maintain our position among the Nations, we must in this respect make a radical change of our pre-war methods. A well-known engineer of wide reputation spoke to me not so very long ago of "those stupid chemists!" and an able Professor of Chemistry said in my hearing, more recently, that "Engineers were such stupid people!" Neither profession deserves such reproaches. The engineer should be taught sufficient chemistry to be able to appreciate the chemist's point of view, and the chemist should know enough of engineering to realize that with the engineer thus trained he can leave the practical application of the processes he devises in the laboratory and supervises in the chemical works.

I have had costly experience of the engineer working in a water-tight compartment of his own, and of the chemist doing likewise. Both courses result in inefficiency. The plan I have found to meet all such difficulties is to organize two distinct staffs under the headship of a chemist on the one hand, and of an engineer on the other, who consult with each other and work together in overcoming the difficulties which daily confront them. I should be sorry to go back to any other system. Chemists and engineers may, I think, be looked upon as the physicians and surgeons of industry, with their respective parts to play in building up and maintaining in increasing strength the well-being of chemical science, and extending its usefulness in the service of man.

THE PREPARATION OF PICRIC ACID AND OTHER NITRATED PHENOLS

By Carleton Ellis, Louis Rabinovitz and A. A. Wells*

Experiments in Connection with a Method for the Production of Picric Acid from Chlorbenzol Are Here Described—In Employing the Dinitrochlorbenzol Process, the Writers Obtained, After the Preliminary Preparation of Three Intermediates, Picric Acid of High Purity Without Resorting to Recrystallization.

THE recent demand for picric acid as an explosive and for use in the dyestuff industry has given a marked impetus to the manufacture of this material.

Picric acid may be obtained by the action of strong nitric acid on various organic compounds such as indigo and certain vegetable resins, etc. Such methods, however, in the main are only of scientific interest and are not considered feasible for the manufacture of picric acid on a large scale. The standard process for preparing picric acid on a commercial scale involves the use of phenol. This method has long been known and has been thoroughly studied, and needs but little comment, as the literature on this subject is very comprehensive. In brief, the usual method consists in sulphonating pure phenol by reacting on it with concentrated sulphuric acid until completely soluble in water, and subsequently nitrating the phenol sulphonic acid thus obtained with nitric acid of about 1.3 sp. gr. Such a procedure is, of course, subject to a number of variations.

At the present time a considerable amount of the phenol used in the manufacture of picric acid is prepared directly from benzol. This is due to the limited supply of phenol from coal tar available on the market. The preparation of phenol from benzol is a lengthy operation involving sulphonation and a caustic soda fusion. The number of steps required and the losses in each step render the method a costly and somewhat difficult one.

Benzol to Picric Acid by Another Route.

The writers have devoted a considerable amount of study to the production of picric acid from benzol by another route—namely, benzol ⟶ chlorbenzol ⟶ dinitrochlorbenzol ⟶ dinitrophenol ⟶ picric acid, and some of the results obtained are of interest from a number of standpoints.

In connection with the preparation of picric acid by the methods described below a brief outline will be given of the reactions involved:

Benzol in the presence of a catalyzer and under proper conditions acts according to the following reaction:

1. $C_6H_6 + Cl_2 = C_6H_5Cl + HCl$.

Chlorbenzol on nitration gives mononitrochlorbenzol (ortho and para), or dinitrochlorbenzol depending upon the intensity with which the nitration is carried out. The reactions are as follows:

2. $C_6H_5Cl + HNO_3 = C_6H_4NO_2Cl + H_2O$.
3. $C_6H_5Cl + 2HNO_3 = C_6H_3(NO_2)_2Cl + 2H_2O$

The mixture of ortho and para nitrochlorbenzols obtained by reaction (2) can be hydrolyzed under pressure with caustic soda giving the corresponding sodium nitrophenates.

4. $C_6H_4NO_2Cl + 2NaOH = C_6H_4NO_2ONa + NaCl + H_2O$

The hydrolysis with alkalies of the dinitrochlorbenzol can be carried out at atmospheric pressure, and is represented by the following reaction:

5. $C_6H_3(NO_2)_2Cl + 2NaOH = C_6H_3(NO_2)_2ONa + NaCl + H_2O$

The salts of these nitrophenols, which are readily soluble in water, are acidified in order to set free the phenol.

6. $C_6H_4NO_2ONa + HCl = C_6H_4NO_2OH + NaCl$
7. $C_6H_3(NO_2)_2ONa + HCl = C_6H_3(NO_2)_2OH + NaCl$

These nitrophenols on further nitration are converted into picric acid.

8. $C_6H_4NO_2OH + 2HNO_3 = C_6H_2(NO_2)_3OH + 2H_2O$
9. $C_6H_3(NO_2)_2OH + HNO_3 = C_6H_2(NO_2)_3OH + H_2O$

EXPERIMENTAL.

CHLORBENZOL.

The apparatus used for making chlorbenzol consisted of a steel tank having a cooling coil and an agitator. This tank was fitted with an inlet pipe for the introduction of chlorine and an outlet pipe for hydrochloric acid. The outlet pipe was connected to an absorber containing water in which the hydrochloric acid was collected. The tank was also fitted with a riser pipe to serve as a rectifying column and connecting to a water cooled condenser. The operation of the apparatus was as follows:

Benzol mixed with about one-half per cent. of iron catalyzer was introduced into the tank, and chlorine was bubbled through it at a fairly rapid rate. The agitator was run rather rapidly in order to prevent local heating. This is necessary, for if the benzol becomes hot, a large amount of dichlorbenzol is formed, and the dichlor compound is objectionable for the present purposes. The chlorine gas employed was supplied from cylinders of liquid chlorine. The chlorine cylinder was placed on a scale and connected by means of a flexible hose. In this way the rate of flow could be controlled, and the end of the operation indicated when the predetermined amount of chlorine had been passed in. As soon as this point was reached the chlorine was turned off and steam turned into the coil.

---

*Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

Removal of Acid Fumes.

During the first experiment no special precautions were taken to collect the hydrochloric acid which was dissolved in the chlorbenzol, and as soon as heat was applied acid fumes came off in great quantities. In later experiments a U trap was placed at the end of the condenser and a vent pipe for the hydrochloric was inserted between the trap and the condenser. The acid fumes were then led off and no more trouble was encountered in this way. It was found on distillation in the chlorination apparatus that the rectification of the chlorbenzol was not efficient, but that further purification was necessary. The fractions obtained from this distillation were separately redistilled in a laboratory still using a fractioning still head, and the combined results indicated a total yield of materials approximately as follows:

Unchanged benzol 15 per cent.
Monochlobenzol 15 per cent.
Dichlorbenzol 10 per cent.

As the unchanged benzol can be returned to the apparatus and treated with more chlorine, it is feasible to obtain yields up to 85 to 90 per cent. of monochlorbenzol. The temperature, however, must be maintained fairly low, best below 20°C.

MONONITROCHLORBENZOL METHOD.

Another method for the preparation of picric acid from chlorbenzol involves the following steps: (1) The conversion of chlorbenzol into a mixture of ortho and para mononitrochlorbenzol by means of a mixture of nitric and sulphuric acids. (2) The hydrolysis of this mixture of nitro products under pressure with aqueous sodium hydroxide. (3) The liberation of the ortho and para mononitrophenol from their corresponding sodium salts by means of acid. (4) The conversion of these mononitrophenols into picric acid.

Mononitrochlorbenzol is readily obtained by the action of a mixture of commercial sulphuric acid (66° Bé) and nitric acid (39° Bé) on monochlorbenzol. The following illustrates the method of preparation:

One part (by weight) of chlorbenzol was gradually added to three parts (by weight) of a mixture of equal parts (by volume) of sulphuric (sp. gr. 1.8) and nitric acid (sp. gr. 1.43). In order to check the violence of the reaction it was necessary to cool the reaction vessel by immersing it in cold water during the introduction of chlorbenzol into the acid mixture. The oil was then separated from the spent acids, washed and dried. A yield of about 95 per cent. of the theoretical was obtained. By several crystallizations from alcohol it was found that the mixture was made up of about 48 per cent. of the para compound, melting at 81°C. (Melting point given in the literature is 83°C.), and 52 per cent. ortho derivative, which melted at 28°C.

Pressure for Conversion to Sales.

One part of the mixed nitrochlorbenzols was heated in an autoclave for 4 hours at 60 pounds pressure, with one part of sodium hydroxide and 20 parts of water. The conversion of the nitrochlorbenzols into the sodium salts of the nitrophenols was practically quantitative. The amount of tar formed was slight, and the sodium salts on cooling crystallized out as well defined needles. The use of more concentrated solutions of sodium hydroxide in the hydrolysis is not advantageous, as they tend to form considerable amounts of tarry bodies.

Milk of lime was used in several experiments in the place of sodium hydroxide solution, but without success, the nitrochlorbenzols being recovered practically unchanged.

Mononitrochlorbenzol was boiled at atmospheric pressure with a large excess of a concentrated solution of sodium hydroxide. With the exception of a slight amount of resin formation the action of the alkali was negligible.

In those experiments where the tar formation was most marked it was observed that only a small amount of ortho nitrophenol was obtained on distilling the mixed nitro phenols. This would seem to point to the fact that the ortho derivative is more prone to decompose than the para compound. This fact, however, has not been definitely established.

The liquid from the autoclave was filtered, acidified cautiously with dilute acid, cooled and treated with sodium chloride to saturation to separate the nitrophenols.

The conversion of the nitrophenols into picric acid was effected as follows: One part of the mixed mononitrophenols was treated with eight parts of an acid mixture consisting of one part nitric acid (1.42) and three parts sulphuric acid (66°Bé). The addition of the acids was made gradually under cooling and agitation. The mixture was then stirred for three hours at room temperature. The temperature of the nitrating mixture rose during this operation to 90°C. The liquid was poured into cold water and the picric acid was filtered, washed and dried. The product obtained was good in color and free from resinous bodies. The melting point was 120°C. The yield was approximately quantitative.

DINITROCHLORBENZOL METHOD.

The dinitrochlorbenzol process for the manufacture of picric acid directly from benzol consists of the following principal steps: (1) The conversion of benzol into chlorbenzol by means of chlorine and a chlorine carrier; (2) the nitration of the chlorbenzol to dinitrochlorbenzol by means of sulphuric and nitric acids, or sulphuric acid and sodium nitrate; (3) the hydrolysis of the resulting dinitrochlorbenzol with sodium hydroxide, sodium carbonate or calcium hydrate; (4) the acidification of the dinitrophenate solution; (5) the further nitration of the dinitrophenol thus obtained to picric acid. Each one of these steps is simple, the yields in most cases are almost quantitative, and the apparatus required in carrying out these steps is not elaborate.

Results of Various Methods.

In the matter immediately following a number of laboratory observations on the nitration of chlorbenzol are noted:

One part (by weight) of chlorbenzol was slowly run into a cooled mixture of three parts of fuming sulphuric acid (20 per cent. free SO_3) and two parts of nitric acid (sp. gr. 1.42), and the mixture was heated under reflux condenser and stirred for two hours. The temperature of the mixture was gradually brought up during this time to 160°C. It was then poured into ice cold water, and the solid dinitrochlorbenzol which had formed was washed free from acid and dried. The product obtained melted at 48°C. 1, 2, 4—dinitrochlorbenzol melts at 51°C. The yield obtained was about eighty per cent. of the theoretical. Any appreciable decrease in the amount of the nitric or sulphuric acid employed gave a dinitrochlorbenzol contaminated with the mononitro compounds, the amount of the latter increasing as the amount of acids used was decreased.

The experiment was repeated, the temperature being kept at 100°C. The product obtained under this change of conditions consisted largely of a mixture of ortho and para mononitrobenzol.

Fifty parts (by weight) of nitric acid (sp. gr. 1.42) and fuming sulphuric acid, and 25 parts of chlorbenzol mixed with the usual precautions and heated for three hours, with stirring, under reflux condenser at 160 to 170 C. gave seventeen parts of pure dinitrochlorbenzol and twenty parts of oily material, which consisted of a mixture of ortho and para nitrochlorbenzol and some dinitrochlorbenzol.

A mixture of fuming nitric acid (sp. gr. 1.6) and commercial sulphuric (66°Bé) gave satisfastory results. One part (by weight) of chlorbenzol and three parts each of fuming nitric acid (sp. gr. 1.6) and of ordinary sulphuric acid heated under reflux and stirring for three or four hours gave a dinitrochlorbenzol, which contained only traces of the mononitro product. The yield of dinitrochlorbenzol as obtained by crystallization from alcohol was fully seventy-five per cent.

A mixture of 66 sulphuric acid and nitric acid (sp. gr. 1.42) reacted with chlorbenzol to give a heavy oil which did not crystallize on standing. This oil was found to contain mononitrochlorbenzol and small amounts of dinitrochlorbenzol

Use of Chile Saltpetre Possible.

The preparation of a fairly pure dinitrochlorbenzol was readily effected by the use of sodium nitrate and commercial sulphuric acid. It was not essential that the sodium nitrate should be pure, as it was found that Chile salpetre gave satisfactory results In the case of Chile salpetre, however, it was considered advantageous to allow the sulphuric acid to act on the sodium nitrate for a short time before introducing the chlorbenzol, as chlorine, liberated from any sodium chloride present in the crude sodium nitrate under these conditions, might effect a further chlorination of the chlorbenzol. A nitration mixture which gave good results was prepared from three parts of sodium nitrate and six parts of commercial sulphuric acid (66°Bé). To this mixture one part of chlorbenzol was slowly added, and the reaction mass was kept at a low temperature by water cooling. The nitration was carried out under a reflux condenser and continuous stirring. The temperature was raised very slowly in order that the evolution of nitric oxide fumes might not become too vigorous, as this would result in a loss of nitric acid and an incomplete nitration. In the case of experiments carried out on a small scale, nitration was completed in four hours. The temperature during the first hour was maintained at 85 to 100°C., during the second and third hour at 130°C., and at 140 to 160°C. during the last hour. Investigations on a larger scale showed that it was unnecessary to employ such high temperatures. On the other hand the time in that case is advantageously extended considerably. Thus, in one test, 138 lbs. of 66°Bé sulphuric acid were added slowly to 56 lbs. of Chile salpetre, and the mixture was agitated in a jacketed iron kettle provided with a cover, reflux condenser and heavy iron stirrer, until the odor of chlorine was no longer noticeable. The chlorbenzol was then added slowly under constant cooling. The mixture was heated to about 90°C., and maintained at 90 to 100° for about five hours, at 110° for nine hours and at 130 to 136° for ten hours, making a total nitration period of twenty-four hours. A yield of upward of ninety per cent. of the theoretical was obtained. The product contained traces only of mononitrochlorbenzol.

Dinitrochlorbenzol has a very irritating action on the skin, and should therefore be handled with caution.

Dinitrophenol.

The hydrolysis of dinitrochlorbenzol by means of sodium carbonate was found to be a slow procedure. For example, 1 part by weight of dinitrochlorbenzol was heated under reflux condenser for eight hours with a boiling solution of two parts sodium carbonate in fifteen parts of water. About 40 per cent. of the dinitrochlorbenzol remained unchanged. Experiments with 20 per cent. and 30 per cent. solution of sodium carbonate failed to completely hydrolyze the dinitrochlorbenzol even on fairly prolonged boiling.

Solutions of sodium hydroxide split off the chlorine from dinitrochlorbenzol much faster and probably more completely than solutions of sodium carbonate. Two parts (by weight) of dinitrochlorbenzol were heated under reflux condenser and stirred, with a solution of one part of sodium hydroxide in nine parts of water, for a period of about an hour and a half. At the end of this time the dinitrochlorbenzol was completely hydrolyzed. Small amounts of mononitrochlorbenzol usually accompany the dinitro compound. The former compound was not affected by the alkali, and was removed in this case by blowing steam through the solution until the vapors were free from the odor of mononitrochlorbenzol. The hot solution of sodium dinitrophenate was then filtered to remove traces of the flocculent material. On acidifying the solution, the 1.2.4 dinitrophenol separated as a brownish crystalline precipitate. Experiments were carried out with more concentrated solutions of sodium hydroxide than that employed in the preceding, but difficulties were encountered with the more concentrated solutions, because a portion of the sodium dinitrophenate crystallized out from the hot liquors, even on slight cooling, rendering the material troublesome to handle.

Hydrolysis with Slaked Lime.

The hydrolysis of dinitrochlorbenzol with freshly slaked lime is best carried out in the presence of a large excess of water. The operation requires more time than the hydrolysis with sodium hydroxide. Stirring, reflux condenser and steam distillation for the removal of the steam volatile impurities are necessary, as in the case of sodium hydroxide. Five parts (by weight) of dinitrochlorbenzol, two parts of freshly slaked lime and one hundred parts of water were boiled under reflux condenser for 3¼ hours while subjected to continuous agitation. After an hour or so a voluminous precipitate of basic calcium dinitrophenolate was formed. This precipitate redissolved after an hour or two of boiling so that at the end of the treatment there was present only a slight precipitate. The solution was filtered, steam distilled and acidified with hydrochloric acid. The dinitrophenol obtained was light in color, but the melting point was low (108°C.) The pure calcium salt of dinitrophenol resembled the sodium salt in physical appearance. It was readily soluble in water and easily converted into an insoluble salt, apparently of a basic nature, on washing with large amounts of water. Care should be exercised in handling salts of dinitrophenol, sodium dinitrophenate, for example, when brought in contact with a flame will explode with marked violence.

Operations on Large Scale with NaOH.

The hydrolysis on the large scale of dinitrochlorbenzol offered no special difficulties. The dinitrochlorbenzol was placed in a capacious iron kettle provided with a closed steam coil, a live steam coil, a stirrer of the propeller type, and a reflux condenser. Two draw-offs were provided, one on the side of the kettle about six inches from the bottom from which the major portion of the solution was drawn, and the other on the bottom from which the residues, which are not hydrolyzed by the caustic solution and not volatilized by steam, are drawn off. A solution of 50 lbs. of caustic soda in 100 gallons of water was added to the dinitrochlorbenzol, and the mixture boiled for 2½ hours. Live steam was then run in for about one hour, or until the steam from the outlet pipe was practically odorless. An appreciable amount of oil was blown over with the steam.

A slight excess of 10 per cent. H_2SO_4 was placed in a tank provided with a slowly revolving wooden stirrer. The clear solution of sodium dinitrophenate from the hydrolyzer was then run into the acid solution in a slow stream under agitation. This method of precipitating the dinitrophenol insured a light colored product of good melting point. A somewhat darker colored product was obtained on adding the liquids in the reverse order. The yield by this method was about 93 per cent.

Acidification of Dinitrophenol.

The conversion of dinitrophenol into picric acid introduces no special difficulties. Experiments on the small scale showed the addition of the third nitro group to be a readily controlled reaction. Large scale experiments did not give any new complications. One part (by weight) of dinitrophenol and two parts of 66° Bé sulphuric acid were placed in an earthenware crock set in a sulphuric acid bath, which, by means of a coil of lead pipe, could be heated and cooled at will. The mixture was cooled and one part of nitric acid was added. The temperature was raised very slowly to 100-110°C. and maintained for three hours. The mixture was then poured into cold water, the picric acid was filtered through cloth filters and washed with a small amount of cold water. The picric acid obtained was good in color and melted at 120°C. At 295°F. the liquid fusion of the picric acid was slightly brown in color.

Conclusion.

Regarded as a whole the dinitrochlorbenzol process for the manufacture of picric acid compares favorably with the process involving such a complicated procedure as the preparation of pure phenol from benzol. Starting with a fairly pure chlorbenzol such as is available on the market in considerable quantities one can arrive at a product of high purity without resorting to recrystallization. This is of interest when one considers that three intermediate compounds are prepared before picric acid is finally obtained from chlorbenzol, and that crude sodium nitrate and commercial sulphuric acid are used in the process.

Such impurities as benzol or mononitrochlorbenzol resulting from imperfect fractionation or incomplete nitration of the chlorbenzol are eliminated during the hydrolysis of the dinitrochlorbenzol.

Direct Method.

An interesting process of preparing picric acid directly from benzol is that of Wolffenstein and Böters (German Patent 194,883, 1907) who prepared picric acid directly from benzol using mercuric nitrate as a catalyzer. A mixture of 400 grms. of benzol, 1,350 grms. of nitric acid (sp. gr. 1.39) and 50 grms. of mercuric nitrate are stated to give 380 grms. of picric acid, 160 grms. of nitrobenzol and 2 grms. of orthonitrophenol. Some work carried out in this laboratory along this line did not meet with much success. A large amount of resinous material formed The yields of picric acid obtained by this process were never above fourteen per cent In one experiment 25 grms. of mercury were dissolved in an excess of

(Concluded on Page Following.)

AMERICAN DYES—AFTER THE WAR

Will This Industry Be Able to Maintain Its Foothold?*

By B. R. Armour

B. R. ARMOUR.

Some of the Non-Technical Phases of the American Dye Situation Are Discussed by the Writer, Whose Views, Because of His Knowledge of the Subject, Should Be of Interest to Every Chemist and Manufacturer Connected with the Industry. Herein Is Described the Sort of Competition We May Look for After the War, and Suggestions Regarding Tariff Legislation Based on Standards of Concentration Are Given. Incidentally, in the Factory of American Aniline Products, Inc., Harrison, N. J., Which Mr. Armour Represents, None But American Chemists, Born and Trained in This Country, Are Employed.

IN the past, the German manufacturers of dyestuffs have effectively controlled the Swiss manufacture by supplying the latter branch of the industry with its intermediates. Take, for instance, the color Sky Blue, which we have succeeded in developing. It is produced from the base known as dianisidine. The production of dianisidine is an intricate and expensive process, involving the smelting and refining of zinc. The Swiss color factories did not attempt to make dianisidine, but procured it from the German dye plants, who supplied it under an agreement whereby they could control the price at which the Swiss manufacturers sold Sky Blue. This price was a fair one to the Swiss, giving them a profit of 50 per cent. But, due to the greater production of the color in German plants and its resulting lower cost of manufacture, this price gave the German manufacturers a profit of 100 per cent. By this method the German monopoly virtually controlled the Swiss industry, showing us the sort of competition we can expect after the war.

Fight Will Be Bitter.

In fact, against our concern this competition has already begun. We are the only American dye company specializing in the intricate, expensive colors, having developed a line that will be complete for all fibers in the textile industries by the end of January, 1917. When the *Deutschland* made her first trip to the United States she learned that we were producing these expensive colors, which were, in general, the sort of colors she brought with her, the German manufacturers being aware that the development of the cheaper colors in this country had progressed on a large scale since the war started.

Her cargo instantly met with our competition, and the result was that on her second voyage she brought large quantities of these dyes and proceeded to cut our prices, attempting to weaken us during the progress of the war by ruinous competition. Naturally, in the production of such colors as we are making, the development is slow and our first costs high. The *Deutschland* on her first trip brought no Victoria Blue, an expensive color. When the German manufacturers learned that we were producing this color they shipped practically all the Victoria Blue left in Germany on the second voyage of the *Deutschland*.

The Swiss Colors Co. was organized in 1907 as importers. American Aniline Products, Inc., was organized in 1914 to engage in manufacture. At the beginning a number of chemists of foreign birth and training were employed, but certain mysterious factory experiences, which almost proved disastrous to the new concern, led its heads to believe that their chemists wished them no good luck in their enterprise.

We are certain that one of our chief employes in those first months of our undertaking, if not actually in the pay of the foreign dyemakers, was at least in accord with their policy not to allow competition to develop in other lands. We noticed it in our yields, which continued to be away below normal, without visible progress being made toward better results. These processes are so expensive that unless they early begin yielding dyes in large quantities they might easily ruin the firm which is paying for them. We discovered this unsatisfactory condition in time to save ourselves, and since then we have em

---

*From the Washington "Observer"

(Continued from page 25.)

nitric acid of 1.39 sp. gr. and this solution was then treated with 200 grams of benzol and 100 c.c. of nitric acid of the same strength. The mixture was then heated for several hours on a steam bath under reflux and then steam distilled until the distillate was practically free from nitrobenzol. The residue in the flask after three successive crystallizations carried to remove the resins gave about 13.6 per cent of picric acid melting at about 117 C. Various other bodies were tested as catalyzers in place of mercury, but without success. Among the substances tested were the nitrates of uranium, cadmium, bismuth, chromium and cerium; also chromic, molybdic and vanadic acids. In no case was there obtained more than a trace of picric acid. The general procedure was to mix 8 parts of benzol, 1 part of the substance to be tested as a catalyzer and about 30 parts of nitric acid (sp. gr. 1.39) and to boil the mixture on a hot water bath under reflux condenser until there was no further evolution of red nitric oxide fumes. The product was steam distilled in order to separate nitrophenol and the unchanged benzol from the picric acid. Chlorbenzol was nitrated with 5 parts of nitric acid (sp. gr. 1.4) in the presence of small amounts of mercuric nitrate without obtaining any picric acid or picryl chloride. Nitrating experiments carried out on nitrobenzol and dinitrobenzol in the presence of mercuric nitrate also failed to give picric acid.

ployed none but American chemists, born and trained in this country. We have had some difficulty in curbing the enthusiasm of these young fellows. American-like, they are apt to become fascinated by the possible uses of by-products and turn aside from the main lines of investigation which they are following up. But they have brought our yields up to standard.

I wish to correct the impression that American dyemakers have been reaping huge profits from the war. Wages are so high and crude materials so expensive that the profits have not been anywhere near as much as the selling prices might indicate. Moreover, these profits in large part have been immediately invested in plants—the American dyemakers have been working for a manufacturing apparatus, which will be of inestimable permanent value to this country in the future.

Domestic Industry Not Yet Secure.

I do not by any means regard the domestic market as conquered by the domestic manufacture. It is evident that, in spite of the good satisfaction which our domestic dyes are giving, the American color users, in large part, expect to get their colors in the future where they can buy them cheapest. If because of an inadequate protection in the tariff the German producers are able to undersell us, they will get the business back again. The recent peace flurry showed that we are not as secure as some of our manufacturers supposed. The peace talk in December absolutely upset the color market. No contracts could be made as long as there seemed to be a chance for peace, and our sales dropped away off. I know of one firm in this country which had been buying colors at the rate of $10,000 a month. In December this concern refused to buy any colors except at ruinously low prices.

For the next year, at any rate, the prosperity of the domestic industry will depend upon the continuance of the war. At the end of that time we may have improved our factory efficiency to the point where we can offer competition in certain lines. But, even then, we cannot expect to maintain a complete industry in this country unless we get more tariff legislation. As far as this company is concerned, we are setting aside every dollar we can spare from our actual factory needs to form a reserve to tide us through the critical period following the war.

New Dye Tariff Insufficient.

The new dye tariff enacted by Congress is insufficient in many particulars. The specific rate of 5 cents a pound added to 30 per cent. *ad valorem* is not nearly enough to protect the more expensive colors, the specific rate amounting to an equivalent of 10 per cent. or less *ad valorem,* a very slight increase in protection over the old rate, which was entirely inadequate, as the state of the industry showed. What we need, in my opinion, is a sliding scale of specific duties, graduated so as to give an equal amount of protection to all colors.

Then I believe that the government should establish standards on which the duties should be based. For instance, the standard of Scarlet, as it is now in use and as it has been imported in the past, is only one-third of the strength to which this color can be concentrated. Undoubtedly the importer of the future will bring in his color three times as strong as in the past, cutting the specific duty to one and two-thirds cents a pound, instead of the five cents which Congress intended. Many other colors can be concentrated to evade duty and then reduced again with neutral substances after they have been imported. In future tariff making we should list colors according to groups and figure the tariff rate on the highest possible concentration.

AMERICAN COLOR MAKERS PRODUCE OWN INTERMEDIATES

One of the pleasing results of the temporary throttling of the American dye industry by the European war is the recent achievement of the Sherwin-Williams Company, which, with the aid of a corps of chemical engineers, has developed and erected a plant at Kensington, Ill., for the production of intermediates which were previously imported. Their initial step was the manufacture of Beta Naphthol and Paranitraniline, for which they had previously been obliged to look to foreign producers. They have also been successful in the commercial production of Metanitroparatoluidine and Paranitranilinesulfonic acid, from which are manufactured Helio Fast Red R and Lake Red P. All organic chemicals are manufactured from refined coal tar products, Benzol, Toluol, Zylol and Naphthalene, and in the utilization of their by-products they have also engaged in the manufacture of Glacial Acetic Acid.

ONE FORMULA—104 COLORS, IS ACHIEVEMENT OF DR. WOLF

The recent perfection of a formula which, it is said, will develop all colors and black, and will render American dyes absolutely fast, giving them a brilliance equal to the German dyes available before the war, has been announced by Dr. Willy Wolff, chief chemist of the Phoenix Knitting Works. In experiments, 104 colors have been developed from this formula.

In a statement to the press, Dr. Wolff said: "The impression should not prevail that I have succeeded in making a new kind of dyestuff. What I have done is to discover a certain combination of chemicals, all made in this counrty, which will simplify fabric dyeing and produce better results with less dye materials. Dyemakers have experimented for years to 'develop' direct colors, but, so far as I know, this is the first time it has been successfully and commercially accomplished."

THE ESTIMATION OF FREE ACIDS IN SOLUTION

Methods for the Determination of Uncombined Sulphuric, Nitric and Picric Acids in the Presence of Each Other.

By F. W. Richardson, F. I. C.*

Experiences Encountered While Determining the Acids Present in Effluents from Picric Acid Works Led the Writer to Abandon Solvent Processes in Favor of Colorimetry, the Pure Yellow Color of Picric Acid Solutions Being Easily Comparable With the Yellow Units of Lovibond's Tintometer.

THE estimation of sulphuric and nitric acids in the presence of each other presents no special features, and good results may be obtained by well-known methods. The entrance of the third factor, picric acid, creates difficulties. Effluents from picric acid works contain much sulphuric and but little nitric acid, with some picric acid from the wash liquors obtained in the subsequent purifying processes.

In pure solutions picric acid can be very easily estimated. The hydroxyl group gives to the acid the characteristics of quite a strong univalent acid. As the molecular weight of picric acid is 229, 1 c.c. of decinormal alkali is equivalent to 22.9 milligrams of the acid, an undesirably large figure when the analyst is dealing with minute amounts. In a direct titration of 70 c.c. of an effluent 0.1 c.c. of N/10 alkali would represent 2.29 milligrams or 2.29 grains per gallon of the acid.

Methyl Red Is Good Indicator.

I find that while phenolphthalein and methyl orange are good indicators for picric acid, methyl red is more delicate than either. I cannot agree with Minovici and Kollo that the use of phenolphthalein requires an excess of alkali to give the end point. Nevertheless these chemists are right in recommending methyl red (p-dimethylaminoazobenezene-o-carb-oxylic acid). The end-point is very sharp—the passage from bright red to orange and from orange to pure yellow requires only two drops of decinormal alkali. Iodo-iodate of potassium has been recommended by Sanders:

$$6C_6H_2(NO_2)_3OH + 5KI + KIO_3 = 3H_2O + 6C_6H_2(NO_2)_3OK + 3I_2$$

One molecule of the acid liberates one atom of iodine; therefore the value of 1 c.c. of the thiosulphate is exactly that of 1 c.c. of decinormal alkali. Leo Schwarz finds that complete reaction only occurs when the solution has been heated for some time in a closed vessel at 100° C.

I have found that 0.5 grams of picric acid in 100 c.c. of aqueous solution at 15° C. required 13.5 c.c. of N/10 thiosulphate, equivalent to only 0.309 grams or 61.8% of the picric acid taken, and that the heating process described by Schwarz was necessary. For several reasons the use of iodo-iodate is not to be recommended. The delicacy is no greater than that of methyl red. Heat is required and iodine is volatile. During the heating process free iodine acts upon organic matters present in effluents and introduces a loss, minimizing the true proportion of picric acid.

Benzol and Ether Undesirable Solvents.

I have tried to utilize the well-known properties of such liquids as benzol and ether for dissolving picric acid, but the results have not been encouraging. Benzol is troublesome on account of the readiness with which it forms emulsions. Ether dissolves so much water that repeated washings with water are necessary, and the peculiar manner in which picric acid passes from ether to aqueous liquid, and vice versa, is most disturbing. Moreover, most stream and river waters polluted with the effluents from picric acid works contain only very small amounts of the acid itself, say from 1 to 3 grains per gallon. I have therefore abandoned solvent process and have resorted to colorimetry. Picric acid solutions have the great advantage of being pure yellow, and are easily comparable with the yellow units of Lovibond's tintometer.

One hundred parts of cold water dissolve about 0.6 part of picric acid; this represents about 420 grains of the acid in a gallon of water. A solution containing only 2 parts of the acid in a million parts of water or 1/7 grain of the acid in a gallon can be readily matched as to its yellow color in a one-inch cell. By using much longer cells quantities as little as 1/50 grain of picric acid in a gallon can be matched, and therefore estimated.

It is not very troublesome to work out charts giving the values of thicknesses of picric acid solutions varying from 1/8 of an inch to 24 inches. In the case of the longer cells I use the special arrangement devised by Mr. Lovibond. To avoid complications I use a glass cell which happens to give 23/25 of an inch thickness of liquid.

Color Depth Increases with Temperature.

I do not recommend a greater range of units than from 0.5 to 6.0. By dilution or concentration it is very easy to bring the color depth within these limits. One very necessary caution must be made; the color depth of picric acid solutions increases very considerably with rising temperature. The following chart shows the increase in color depths from 0° C. to 60° C., the units increasing from 3.7 to 6.1. From 10° C. to 20° C. the color increases from 4.05 to 4.5 units.

---

*From the Journal of the Society of Chemical Industry. Presented at a meeting of the Yorkshire Section in Leeds, England.

Table A.

Increase of Color-depth on Heating a Dilute Solution of Picric Acid, Using Lovibond's Tintometer.

TABLE A.

C.	Yellow Units.	C.	Yellow Units.
0	3.7	25	4.7
5	3.85	30	4.9
10	4.05	50	5.7
15	4.30	60	6.1
20	4.50		

I have used 15 C. as the most convenient, or the least inconvenient, temperature. In the summer months, particularly in July and August, a scale of unit-values for 20 C., or even 25 C., should be used. This scale can be made in a few minutes.

The following table (B) gives the color-depths of picric acid solutions in a glass cell of 23/25 inch internal diameter. By a direct reading, obtained in a few moments, the amount of picric acid can be estimated when varying from 1.25 to 60 parts per million or 0.0875 to 4.2 grains per gallon.

TABLE B.

Color values of dilute solutions of picric acid in a 23/25-inch glass cell (Lovibond's units).

Yellow units.	Grains of picric acid per gal.	Yellow units.	Grains of picric acid per gal.	Yellow units.	Grains of picric acid per gal.
0.3	0.0875	2.1	0.90	3.5	1.61
0.6	0.1750	2.2	0.92	3.6	1.68
0.8	0.2800	2.3	0.95	3.7	1.82
1.0	0.35	2.4	0.98	3.8	1.84
1.1	0.39	2.5	1.05	3.9	1.86
1.2	0.42	2.6	1.09	4.0	1.89
1.3	0.49	2.7	1.12	4.1	2.03
1.4	0.53	2.8	1.19	4.2	2.10
1.5	0.56	2.9	1.33	4.3	2.16
1.6	0.59	3.0	1.37	4.4	2.24
1.7	0.63	3.1	1.40	4.5	2.31
1.8	0.67	3.2	1.43	4.6	2.38
1.9	0.70	3.3	1.47	4.7	2.45
2.0	0.875	3.4	1.54	4.8	2.52

I find that this chart is sufficient for most stream, river or canal waters containing picric acid effluents. By concentration or dilution to fixed volumes any picric acid solution can readily be brought within this range.

I estimate the nitric acid by phenoldisulphonic acid in the well-known manner with certain modifications, using the table given by Hollings and myself.[3] I have worked out a table giving the values of the color depths in a one-inch (really 13/14 inch) Lovibond cell from 0.1 unit to 6.2 units of yellow, representing a range of 0.002 to 0.139% of nitric nitrogen in the diluted yellow solution (Table C).

An actual example of working may be of value.

Known amounts of the three acids were used in such dilution as fairly to represent a canal or river water containing effluents from picric acid works.

(1) 70 c.c. of the solution when tinged with methyl red required 6.9 c.c. of N/10 sodium hydroxide for neutralization.

(2) 10 c.c. of the solution after mixing with 5 c.c. of N/10 sodium hydroxide was evaporated to dryness on the water-bath. The residue was well mixed with 1 c.c. of phenoldisulphonic acid mixture, and after warming gently for about five minutes the acid liquid was diluted with about 50 c.c. of water, transferred to a 100 c.c. flask, made alkaline with ammonia, cooled to 15° C., and diluted to 100 c.c. In the 23/25-inch glass cell the color depth was found to be exactly 2.3 yellow units (Table C).

TABLE C.

Estimation of nitrogen as nitrates by phenoldisulphonic acid. Value of yellow units (Lovibond) in a 13/14-inch cell.

Yellow units.	Mgrms. N. in 100 c.c.	Yellow units.	Mgrms. N. in 100 c.c.	Yellow units.	Mgrms. N. in 100 c.c.
0.1	0.002	2.2	0.050	4.3	0.095
0.2	0.004	2.3	0.053	4.4	0.098
0.3	0.005	2.4	0.055	4.5	0.100
0.4	0.007	2.5	0.057	4.6	1.103
0.5	0.010	2.6	0.059	4.7	0.105
0.6	0.011	2.7	0.062	4.8	0.108
0.7	0.014	2.8	0.064	4.9	0.109
0.8	0.015	2.9	0.066	5.0	0.111
0.9	0.017	3.0	0.069	5.1	0.113
1.0	0.020	3.1	0.070	5.2	0.115
1.1	0.023	3.2	0.072	5.3	0.118
1.2	0.025	3.3	0.074	5.4	0.120
1.3	0.027	3.4	0.077	5.5	0.122
1.4	0.030	3.5	0.080	5.6	0.123
1.5	0.032	3.6	0.082	5.7	0.125
1.6	0.034	3.7	0.0832	5.8	0.128
1.7	0.037	3.8	0.086	5.9	0.130
1.8	0.039	3.9	0.087	6.0	0.132
1.9	0.042	4.0	0.090	6.1	0.135
2.0	0.045	4.1	0.092	6.2	0.139
2.1	0.048	4.2	0.093		

(3) The original solution of the three acids gave a color in the 23/25-inch glass cell equal to 0.8 yellow unit. Reference to the table shows that this is equivalent to 0.28 grain of picric acid per gallon.

The calculation is now simple: 70 c.c. contains 0.28 mgrm. of picric acid, equivalent to 0.0121 c.c. of N/10 NaOH. The nitric nitrogen found was equal to 0.0533 mgrm. in 100 c.c. or 0.0371 mgrm. in 70 c.c., equal to 0.167 mgrm. of nitric acid, representing 10 times (on account of the tenfold dilution) the amount, or 1.67 mgrms. of nitric acid in 70 c.c. of the original liquid.

1.67 mgrm. of nitric acid is equal to 0.2650 c.c. of N/10 NaOH
0.28 mgrm. of picric acid is equal to 0.0121 c.c. of N/10 NaOH

Therefore the combined nitric and
picric acids represent in 70 c.c.. 0.2771 c.c. of N/10 NaOH

The total acidity of 70 c.c. equaled 6.9 c.c. of N/10 sodium hydroxide, hence the acidity due to sulphuric acid is 6.6229 c.c., or 32.48 grains of H_2SO_4 per gallon.

Grains per gal.	Present.	Found.	Error.
Sulphuric acid	32.60	32.48	0.12
Nitric acid	1.76	1.67	—0.09
Picric acid	0.28	0.28	nil.

I give the following example to show the necessity of deducting the requisite number of yellow units from the cell reading obtained in the estimation of the nitric acid:

4.4 units were required to match the yellow color.
0.7 unit was found to match the yellow color of the liquid itself when a similar tenfold dilution was made.

3.7 yellow units were therefore required for the color developed by the nitric nitrogen alone.

Grains per gal.	Present.	Found.	Error.
Sulphuric acid	15.0	14.2	—0.8
Nitric acid	2.5	2.63	+0.13
Picric acid	2.5	2.52	+0.02

---

[3] Journal of the Society, 1903, 616-617.

Only 70 c.c. of the liquid was used for the total acidity and an error of only 0.16 c.c. of the N/10 alkali was required to account for the error of —0.8 grain of sulphuric acid per gallon.

The intensity of the color given by picric acid to water is evident from the fact that when pure water contains as little as the 1/325th grain per pint of picric acid it will require 2 units of yellow to match the color in a 24-inch Lovibond's cell. This represents about 1/36 grain of picric acid per gallon.

My attention was naturally directed to other methods of estimating nitric nitrogen in the mixtures. Unfortunately the Halle zinc-iron and caustic soda method results in the decomposition of some 37% of the picric acid, and cannot be used. Moreover, any nitric nitrogen reduction process, zinc copper couple for example, applied to extremely small amounts of substance requires final Nesslerization of the small amount of ammonia, and no advantage over the phenol-disulphonic acid method can reasonably be expected.

"Nitron" is now unobtainable; moreover it was quoted at about 10s. an ounce before the war. As a 10% solution of the acetate is used in liberal amounts the process is costly. Also nitron precipitation is only applicable to appreciable weights of nitric acid and nitrates. As the total amount of nitric acid in the samples frequently supplied to analysts does not exceed a few centigrams, a gravimetric process is scarcely advisable.

The Action of Dilute Solutions of Sulphuric, Nitric, and Picric Acids Upon Iron.

Waters containing picric acid effluents often come in contact with iron machinery and iron boilers. It has been suggested that even small amounts of nitric acid in the presence of larger proportions of sulphuric acid might produce corrosive effects far greater than the mere acidity might indicate.

Very dilute solutions of sulphuric acid as compared with solutions containing the same molecular equivalents of nitric acid act even more readily upon chemically clean wrought iron surfaces. Strips of wrought iron 3 inches by 1 inch were immersed for three days at 10°—20° C. in 500 c.c. of acid solutions. The following figures show the proportions of iron dissolved:

Acid.	Iron dissolved.
N/250 sulphuric acid	82
N/250 nitric acid	49
Equal parts of N/250 sulphuric and nitric acids	53

With solutions of ten times these acid strengths the amounts dissolved were 529, 512, and 500 respectively, or in the ratios 105.8 : 102.4 : 100.0.

The dilute nitric acid forms a brown-red coating upon the iron sheet, and this, in the case of very dilute solutions, may well prove slightly protective.

When the diluted acids alone and mixed are boiled down upon sheet iron, a copious brown-red coating appears only in the case of the solutions containing nitric acid.

Addition of water with re-evaporation caused a much greater action upon the iron in the case of the nitric acid solutions. The percentages of action in this case were sulphuric acid, 100; nitric acid, 127; mixed acids, 116.

It was evident that hydrolytic action was caused by the evaporation process in the case of the nitrate of iron:

$$Fe_2(NO_3)_6 + 6H_2O = Fe_2(OH)_6 + 6HNO_3.$$

The nitric acid set free again acts upon the iron.

Nitric acid solutions when concentrated in boilers will therefore produce extensive corrosive action.

Picric acid of N/250 strength (0.0916% equal to 64.12 grains per gallon) readily acts upon iron. My experiments show that as compared with sulphuric acid the amounts of iron dissolved are roughly proportional to the molecular equivalents, 49 parts of sulphuric acid producing the same result as 229 parts of picric acid.

"PIPE AND THE PUBLIC WELFARE."

By R. C. McWane. Published in New York by the Sterling Press. Illustrated.

Something of the ceaseless struggle of mankind, from the days when Babylon was young, 4,000 B. C., to attain a certain ideal—a pipe which will endure under ground—is interestingly set forth in this little book. The author contends that the history of pipe is the history of civilization, for upon no other single product have the great cities of the world depended in such large measure for their health and comfort, and he proceeds to show by records of actual service and various tests that cast iron pipe is, of all varieties, best fitted to safeguard the public welfare, and that it is particularly desirable for pressure conduits. Some very interesting comparisons of the performances, while subjected to hard service, of cast iron, wrought iron and steel pipe are given. The book also contains an account of the materials and methods of making metal pipe, and a comprehensive chapter dealing with the various causes for its deterioration. Altogether, because of the amount of data given, the book should be of interest, particularly to those public officials whose duty is the selection of conduits for the use of future generations.

Drugs and Medicines.

The Durpass Drug Corporation, of Manhattan, drugs, medicines, etc., has been incorporated under the laws of New York by W. F. Drennen, P. R. Gordon, and D. E. Slattery.

Newark Varnish Concern Will Add to Plant.

A contract has been awarded by the Dolph Manufacturing Corporation, varnishes, etc., for the construction of an addition to its plant, 166-170 Emmett Street, Newark, N. J. The cost of the addition will be $6,000.

THE RECOVERY OF GLYCERINE

By G. A. Moore*

Few Soap Factories Are Today Without Facilities for the Reclamation of This Important By-Product, But Although the Methods for Carrying on the Operation Have Been Greatly Improved, There Are Still Many Sources to Be Developed. In the Following Paper, the Writer Briefly Traces the Steps Through Which the Present Processes Were Reached and Points Out Difficulties Which May Yet Be Overcome.

GLYCERINE was discovered by a Swedish chemist named Scheele, in the year 1780. Sobrero prepared nitro-glycerine for the first time in 1847, and twenty years later Nobel invented dynamite.

At about this time glycerine was being utilized in other industries and the increasing consumption induced the manufacturers to recover it with more care.

The stearine candle industry was the main source of supply for many years, the glycerine being produced by the autoclave process, but the high price reached led to the investigation of other sources, particularly the waste lyes produced in the manufacture of soaps.

The presence of salts, alkali, organic impurities and coloring matter in the waste soap lye presented many difficulties and manufacturers met with varied success in their efforts to recover the glycerine. Metallic salts, such as sulphate of iron and alumina, were used in the early stages of lye treatment as coagulating and purifying agents, and many methods of more or less merit were thoroughly tried out. It was not until 1883 that the manufacturers were able to produce from the waste lyes a crude containing 80 per cent anhydrous glycerine and from 10 to 15 per cent of salt. This at once established the position of soap lye crude glycerine, and the refiners, overcoming their prejudice, no longer hesitated to work it.

Improvements in Recovery Methods.

Joseph Van Ruymbeke introduced his method of lye treatment in 1891 and his process for working still foots in 1894. William Garrigue in 1904 developed his process for the elimination of volatile fatty acids from the crude previous to distillation. Constant effort has so improved the processes that the soapmaker now has no difficulty in producing a good crude; dynamite grade can always be made in one distillation and chemically pure glycerine in two.

The improvement of the apparatus used in the recovery of glycerine kept pace with the developments in processes. Much of the early success of the manufacturers in recovering the glycerine from waste lye was due to the efforts of Scott. The first use of vacuum in distillation was made in 1882 by F. Armandy. O. Laist in 1883 applied the air condenser to glycerine stills. Van Ruymbecke in 1891 combined the use of high vacuum with heating the still by means of saturated steam and injecting saturated steam, and in 1894 applied the injection of expanded and reheated steam to stills. Garrigue in 1904 used the heat of the vapors from the still for superheating the low pressure steam injected into the still.

Characteristics of Waste Lyes.

Spent lyes as produced in the soap factories vary in quality, depending on the practice of the soapmakers. As run from the kettle the lyes consist of water holding in solution the salt added to separate the soap, some soap, free alkali in the form of caustic soda and carbonate of soda, albuminous matter in suspension as well as in solution, and the glycerine. If resin and nigre lyes are used there will be much color from the resin and nigre.

The refiner would prefer to receive the lyes free from organic impurities and coloring matter, but the object of passing water through the kettle is to remove the dirt and coloring matter from the soap as well as to obtain a good yield of glycerine. It is advisable, however, to avoid running nigre and resin lyes to the glycerine plant, but this can only be done if the glycerine has been properly removed from the soap before the addition of the resin and nigre.

The yield of glycerine obtainable depends on the amount of lye produced. In average practice the soapmaker will produce about three pounds of lye per pound of stock saponified, which lye will contain at least 90 per cent of the glycerine originally in the stock. Obviously the time to stop washing the soap is when the lye can no longer be evaporated economically.

No lye need be drawn from the kettle of such strength that the average of all the lyes will contain more than 0.4 of 1 per cent (0.4%) total alkali. All lyes will separate some soap on cooling and a storage tank should be provided in which the lyes may cool and the separated soap be skimmed off.

Neutralization of the Lye.

When the lye is ready for treatment the alkali contained is neutralized by mineral acids, and metallic salts are added for removing the organic impurities. Either hydrochloric acid or sulphuric acid may be employed, the former producing sodium chloride and the latter sodium sulphate or Glauber's salt. Glauber's salt is not so useful in graining the soap, so that eventually the salt recovered from the lye has to be wasted or the Glauber's salt separated by crystallization.

The amount of metallic salts used depends on the cleanliness of the lye. They form insoluble metallic compounds which are coagulated when the lye is brought to neutral. If sulphate of alumina is used any excess of free caustic in the lye tends to form aluminum hydrate, which will retard filtering. If the lye is left acid there is a tendency to convert aluminum soap to aluminum sulphate and set the organic matter free. In this case both would go into solution in the lye, pass through the filter and come down in the evaporator, producing a low grade crude. The sulphate of alumina would also corrode the evaporator.

---

*From the American Perfumer.

Properly treated lyes should filter readily and be water white. An excess of alkali gives the lye a yellow color and often it will not filter clear. If the lyes contain much resin lye or lye from lower grades of grease there may be an accumulation of a gummy material on the surface. This should be skimmed off as it will retard filtering and gum the press cloths.

The practice of returning silicated scrap to the kettles should be avoided, unless all the lye for the glycerine plant has been removed. Silicate of soda in the lye is not only a loss of good filler, but causes a loss in acid for neutralizing. When neutralized, silicic acid is set free in its colloidal form and any appreciable amount will retard filtering.

Concentration of Glycerine Liquors.

All lyes will contain nitrogenous matter, the amount varying with the care used in rendering the fats. This matter is not removed in the treatment, most of it appearing in the crude, increasing the figure for non-volatile residue. Lyes stored free from caustic ferment, the nitrogenous bodies decomposing forming sulphites, which give off hydrogen sulphide on acidifying, and some glycerine is converted to trimethylene glycol. Fermented lyes give considerable trouble in evaporation by foaming and the sulphides corrode the evaporator.

There are various types of evaporators for concentrating the glycerine liquors. The evaporation may be done in single or double effect, but more than two effects for spent soap-lye concentration are not practical. The type of machine selected should combine ease of operation and freedom from repairs with capacity and minimum loss by entrainment.

It is preferable to operate in two stages, that is, to evaporate the weak liquor to a half-crude containing about 4 per cent of glycerine and, when a sufficient amount of this half-crude has accumulated, complete the concentration to crude. In this way about 80 per cent of the salt recovered from the lyes is removed from the half-crude and serious trouble from salting of the heating tubes is avoided. Closed salt separators are usually provided for removing the salt during concentration.

Crude glycerine from soap lye is a saturated solution of various alkaline salts in glycerine, together with varying amounts of water, organic impurities and coloring matter. It is sold on a basis of 80 per cent glycerine content and should contain but small percentages of salts and impurities.

Obstacles to Distillation.

The presence of alkaline salts of the volatile fatty acids and organic matter retards distillation and increases the still residues. It is impossible to completely separate the glycerine from the alkaline salts of the volatile fatty acids, some of the fatty acids passing over to the distillate and some glycerine being retained in the still, the amount retained increasing in proportion to the quantity of the alkaline salts in the still. The advantage of the Garrigue process for eliminating the volatile fatty acids from the crude previous to distillation is here made apparent. There is thus in the still a very small amount of volatile acids compared with the amount of glycerine. Also, by almost eliminating the volatile acids there is produced a residue so low in volatile fatty acid salts that the glycerine retained by them is trifling.

Volatile Acids Form Esters.

It is impossible, however, to eliminate all the volatile acids in the process and any not driven off have a tendency to combine with glycerine, forming esters identical in composition with the original fat. At the high temperature of distillation any volatile acid glycerides present would decompose into fatty acids and glycerine and the volatile acids would distill over. The crude is therefore made alkaline in the still, the alkali combining with the volatile acids, holding the greater part of them in the still. The residue in the still will consist essentially of chloride or sulphate of sodium, alkaline salts of fatty acids, some coloring matter and small quantities of glycerine. If the manufacturer wishes to obtain high yields the still residues should be properly re-worked.

If dynamite grade glycerine is to be produced the distillate is concentrated to the desired gravity, bleached with a small amount of decolorizing carbon, filtered and drummed for shipment.

The Production of C. P. Glycerine.

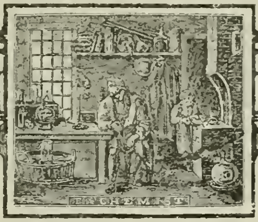
Refined glycerine must meet more stringent tests than crude, the tests for dynamite grade being determined by the powder makers. Crudes made from fermented lyes or greases which have not been washed will contain trimethylene glycol, which, if present in sufficient quantity, will make it impossible to obtain the necessary gravity for dynamite grade and the glycol would have to be distilled off.

To produce chemically pure glycerine the first distillate is bleached with carbon and redistilled. The second distillate is again concentrated, bleached and filtered. Here again the presence of glycol will be objectionable, not on account of gravity but because of the acrid taste which is a property of the glycol. It is necessary, therefore, to remove the glycol and if present in too large a quantity to be disposed of in the dynamite grade glycerine it must be sold as chemically pure glycol.

The tests given in the United States Pharmacopoeia are the ones usually applied to chemically pure glycerine. The presence of arsenic in glycerine used for medical purposes is dangerous. To prevent this, distinction should be made in the sulphuric acid used in treatments. There should be no difficulty in securing acid guaranteed free from arsenic.

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.



BEGINNING with this issue there will be maintained through the columns of "The Chemical Engineer" a bureau of chemistry under the heading "Chemical Investigation, Efficiency and Control," the aim of which will be to assist manufacturers and dealers in effecting the economical control of their products and industrial processes at moderate fees.

The bureau, it is hoped, will be invaluable in preserving the uniformity of the products and control of the processes of those who wish to check the results of their own chemists, or who do not care to undergo the cost of the upkeep of a laboratory of their own.

The bureau will be conducted through this journal by Charles B. Davis, a well-known research chemist of wide experience in all branches of industrial chemistry, chemical and patent causes, and special machinery. From month to month Mr. Davis will answer questions relative to manufacturing processes subject to chemical control, and will undertake, at a nominal cost to readers of "The Chemical Engineer," all types of chemical investigations, with improved apparatus and the most modern methods.

The full scope of the work may be briefly indicated as follows:

Special Research of Every Description.

Analysis and Reproduction of Any Commercial Chemical Product.

Prevention of Waste and Utilization of By-Products on the Most Economical Basis.

Valuation of Raw Materials.

Food Analysis, and Disputed Points in Regard to Adulteration, Labeling, and the Enforcement of Pure Food Laws.

Bacteriological and Enzymatic Examinations, Including Fermentation Tests, Pure Yeast Cultures, Beverages of All Kinds.

Development of Chemical Inventions and Industrial Processes; Examinations and Advice on Special Machinery.

Because many manufacturers are becoming rapidly aware of the value of expert advice on matters relating to their special lines, it is believed that this method of making such advice easily and quickly available will fill a long-felt want. Questions of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will receive attention through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

Charles B. Davis,
care of The Chemical Engineer,
118 East 28th Street,
New York City.

I. D. C. We thank you for mentioning the fact that the working formula furnished is in successful operation and are awaiting the samples of sugar you are now forwarding. (27)

G. W. The time required for the analysis of the mixture you mention will depend entirely on what you wish determined. The samples can be shipped direct to C. B. Davis, consulting editor, The Chemical Engineer, 118 East 28th Street, New York. (36)

L. B. Coals vary in their calorific or heating value to such marked degrees that each shipment should be tested. Considerable money can be saved annually by this means. The ashes should be examined also from time to time in order to ascertain whether or not complete combustion is taking place under your boilers. Samples of at least two pounds should be forwarded for the analysis. (60)

J. K. Butters now appearing on the market are of varied composition, some of which I have found to contain as high a content of water as 35 per cent. Others are mixtures of true butter fat mixed with foreign fats. If you will forward quarter pound samples of those you want analyzed, I will be able to furnish you results in a few days after the receipt of same.

H. M. To prevent spontaneous ignition of your coal a sample should be submitted to careful analysis, as many factors depend on the prevention of this effect. The size, percentage of sulphur, conditions of atmosphere, etc., all tend to bring on this condition. (41)

F. E. B. Your waste sulphite-cellulose liquor can be rendered suitable for cattle feed by proper neutralization, concentration, and mixture with bran. A quart sample is all that will be required to be sent for this purpose. (34)

ANILINE DYES IN THE UNITED STATES

By I. F. Stone*

I. F. Stone.

Mr. Stone Believes That American Chemists and Manufacturers Are Capable of Producing Raw Materials, Intermediates and Formulae from Which Can Be Developed Colors Equal to the Best Imported Dyes, and That the End of the War Will Find Us Well Able to Supply the Domestic Demand at Reasonable Prices. Owing to the Enormously Increased Production of Raw Materials, the Present Situation May Be Regarded as Highly Satisfactory, and American Consumers Should Be Able to Obtain Everything They Need for Next Year.

IN speaking of this subject, and in order to properly compare the present situation with that of a year ago at this time, and previous to the war, I can say that just after the war, in 1914, the situation promised to be very acute, as it was evident that the shipping of colors from Europe would be stopped and there were not sufficient stocks in this country to take care of the consumers for any length of time. This proved to be very true, for as early as January, 1915, there came a great scarcity of dyestuffs and prices commenced to advance to an almost unbelievable extent. The American manufacturers were hampered in producing any additional quantities by the fact that they were buying most of their raw and intermediate materials from Europe, and with the stoppage of the shipments of colors to this country the shipping of these raw materials and intermediates also stopped. Therefore the American manufacturers were almost in as unsatisfactory condition as were the consumers, in their inability to get supplies of the raw materials.

Raw Materials at Home.

For a period, then, from the beginning of the war until about October, 1915, the situation was very acute. But in the meantime, fortunately, arrangements had been made to manufacture a number of the raw materials and intermediate products by the color manufacturers, so that by this time, viz., October, 1915, they were enabled to increase their manufacture to considerable extent. In our own factory we were particularly fortunate in this respect in that the contract for one of our principal raw materials (aniline oil) had been placed with an American manufacturer who had commenced the manufacture of this product a couple of years preceding the war, and whom it was our policy to encourage. This contract for aniline oil, together with our having our own acid plant for the manufacture of sulphuric, nitric, muriatic and other necessary acids, also together with a large stock of foreign raw materials which we always carried, enabled us not only to continue our regular production from the time the war started, but by the fall of 1915, viz., October, increased our production on many of our colors, particularly *direct black,* which was a very serviceable color for cotton and union goods and cotton and silk hosiery.

We were also fortunate enough to be able to produce at practically the same time a very satisfactory quality and quantity of *sulphur black* for cotton goods, in fact as good a quality as had been previously imported, and this, with our *direct black,* was of great service in relieving the situation on these two products. Other manufacturers also at the same time began to get into better condition to make colors, and the situation, therefore, about October, 1915, was much easier than in the beginning of the year, although the production of all these factories even then was not enough to take care of the consumption.

From that time on, however, large increases in the production of the already established factories, and the installment of a number of new factories, commenced to clear the situation so that at the present time the production of the American factories will be enough to take care of the whole consumption of aniline dyes in this country in the future, for all of what I might term staple colors, and the situation therefore at this time is very satisfactory.

All Demands Will Be Met.

In explaining the success of the American factories in reaching this position I must first explain the conditions of raw materials, coal tar, and its derivatives and intermediate materials, which they use in their manufacture. Before the war there were practically no manufacturers of what we call intermediate products in this country, the only exception being aniline oil, of which I have spoken, and this had been only made to a limited extent and not profitably, by reason of foreign competition. The basic materials, however, *benzol, naphthaline,* etc., from which practically all aniline colors are derived, were being produced in this country to quite a large extent; *benzol* for use as a solvent and for other purposes not connected with the manufacture of anilines, and *naphthaline* for a moth destroyer, but upon the demand from the aniline manufacturers for these derivatives, and for explosives and other war purposes, the American producers of benzol commenced to increase their production, and were so successful that at present there is a production of about thirty million gallons per annum, against three million gallons prior to the war. And the production of naphthaline was also largely increased, so that there is an ample supply of these products at this time, and from them are now being manufactured largely such intermediates as aniline oil, beta naphthol, alpha-naphtylamine, paranitranilin, chlorbenzol, dimethylanilin, paraphenylenediamine, etc., so that the American manufacturers of colors are able to get sufficient raw materials to manufacture enough colors to supply the whole consumption, speaking now of a general line of colors, but not of all the colors which were formerly used, there being some specialties made by the European manufacturers which we have not yet begun to manufacture, for reasons which are evident, such as not being able to secure the proper raw materials, or not being able to do everything all at once. But all of these necessary specialties will, however, undoubtedly be manufactured in the near future, so that in my opinion before another year has passed every color which is necessary to American consumers will be produced in this country.

---

*President of the National Aniline & Chemical Company, vice-president of The Schoellkopf Aniline & Chemical Works, Inc.

American Colors Hold Their Own.

There is a popular impression that American manufactured colors are not as good as those manufactured in Europe, Germany particularly, and this is an impression I wish to definitely correct, in that it is not a fact for the reason that the American colors are made from practically the same chemical formulæ as the European colors and are practically the same products in every way, the only difference being that European manufacturers, from their long experience, may get a larger yield from the same formula than the newer American manufacturers, and the American costs may therefore be more, but this does not affect the products which in my opinion are equal in every way to the products made in Europe.

For silk manufacturers, for instance, some of the same colors which they used before the war, have been available since the war—viz., Azo Yellow, Orange, Scarlet, Black, Fast Red, Bismarck Brown, Nigrosines, Indulines, Methylene Blue, Methyl Violet, etc., therefore these colors are just as good now as they ever were, and the goods dyed from them should naturally be the same as before the war. Some of the special colors, however, such as Rhodamine, Auramine, Victoria Blue, Acid Light Blue, Acid Green and Acid Violet, have not yet been manufactured for the reasons I have already mentioned, that is, lack of the necessary raw materials and lack of ability of anyone to take up everything all at once. But these colors, as I have already said, will in my opinion be manufactured before another year has passed. Some of these colors have, however, been imported from England and Switzerland, so that some of them have been available, and the fancy shades produced from them have therefore been more or less obtainable.

In addition to these aniline products for silk dyeing, such vegetable dyes as logwood, indigo, gambier, etc., have been obtainable, so that speaking generally the silk manufacturers have been able to secure practically all the staple products which they need for their purpose, and are now in a very satisfactory condition as to their dyestuff supplies.

For woolen manufacturers we are now able to supply chrome colors suitable for men's wear, sweaters, heavy woolens, etc., in black, blue, brown, green, yellow and red, which are practically equal as to fastness to any colors which have heretofore been manufactured in Europe and for ladies' dress goods, piece dye worsteds, carpets, worsted yarns, etc., we are able to furnish some acid colors in practically every shade, which are in every way equal to European colors.

For cotton goods, we are able to furnish Sulphur black, suitable for all fast work except bleaching, practically all direct colors suitable for all cotton work except a small proportion of wash fabrics such as shirtings, and basic colors such as blue, red, brown and green for printing, etc.

For leather, and other industries, we are also able to furnish practically every color which is needed.

Therefore, the whole situation is at present very satisfactory, and as I have said, every American consumer should be able to obtain practically everything he needs for next year.

"Fast" a Comparative Term.

I might say it has been particularly misunderstood by the public that American colors are not as fast as European colors were, and it seems to be the custom now for saleswomen and others in the stores, as well as the garment dyers, to specifically state that they do not guarantee colors, because they are no longer able to get the foreign colors, and I wish to say in this connection that as far as I know, no manufacturer or retailer has ever guaranteed colors even before the war, although this fact may not have been mentioned, and the only reason it is mentioned now is through a misunderstanding of the situation. Such fancy colors as ladies usually want in silk, worsteds, etc., such as pinks, light blues, light greens, heliotrope, etc., were never fast, and as far as I know, there have never been any colors which would dye them fast. In any event, the word "fast" is more or less a misnomer, as a color which is absolutely fast to everything, such as washing, fulling, light, exposure, alkalies, acids, etc., is practically unknown, so it is only comparative fastness which is meant in speaking of fast colors, and to this extent the present American colors, such as they are, are just as fast as the same colors made in Europe. There are some colors called vat colors, which are unusually fast in the above connections, but they are not manufactured in this country and have never been used to any large extent for light shades. For all ordinary fastness we are now able to furnish colors for cotton, wool and silk in blacks, blues, browns, and some other shades, so that the question of fastness is no longer a question, and it is usually only mentioned by customers who have the wrong impression of conditions.

In connection with the high prices now charged by American manufacturers of colors, many consumers are under the impression that this is because of the high cost of manufacture here as compared with Europe, but as a matter of fact, the reason is the abnormal conditions, in that the raw materials used for the manufacture of colors, like benzol, for instance, are very much higher than normally, being used for explosives and other war purposes, and this high cost of raw materials, together with the high cost of labor, under the present conditions, is what causes the high prices for American colors.

High Prices Prevail Abroad.

And by the way, these high prices also rule in Europe, as is shown by the extremely high prices asked for such colors as have been brought over from Germany by the submarine *Deutschland,* and other colors which are being imported from Switzerland, the prices on all of these imported colors being higher even in proportion than the American colors. Whenever normal conditions again prevail, and raw materials and labor are at normal costs, then the prices of American colors, as well as European colors, will resume the normal figures. In any event, American manufacturers who buy dyestuffs have no reason to complain of the high cost, because they, on their part, have in most cases advanced the cost of their products more than the proportionately higher cost of dyestuffs, for the cost of dyestuffs, as a general rule, is a very small percentage of the cost of manufactured textiles, either wool, cotton or silk, and American textile manufacturers to-day are more prosperous, as a rule, than they ever were.

In conclusion, I wish to call special attention to the three important points in my remarks:

First: That the colors made in America are fully as good in every way as those made in Germany or any other country.

Second: That we are able to furnish colors for most purposes which are fully as fast as German or other European colors, and there is therefore no reason for people not being able to get these fast colors on such materials.

Third: The definite answer, in connection with the manufacture of dyestuffs in America, is, therefore, that the present condition of the dyestuff supply is very satisfactory, and the future outlook is still more satisfactory in that we will make more colors. Everything indicates that the larger part of the business will remain in the hands of American manufacturers even after the war, instead of in the hands of the European manufacturers.

FACTORS AFFECTING THE YIELD AND QUALITY OF PEPPERMINT OIL

The effect on the yield and quality of peppermint oil of cultural and climatic conditions is discussed in professional paper No. 454, by Frank Rabak, Chemical Biologist, Bureau of Plant Industry. This bulletin, recently published by the U. S. Department of Agriculture, is based on experiments in raising and distilling peppermint plants conducted from 1908 to 1912. Conditions of soil and climate, the author finds, are influential factors in the formation of oil and its constituents in the peppermint plant. Light sand or loamy soil appeared to be most favorable for the production of an oil of high quality.

Distillation experiments were conducted with a view to determining the effect on oil yield of drying the plants previously to putting them in the stills. It was found that the yield of oil from fresh plants apparently decreases as the plant matures. Drying the plants before distillation results in a considerable loss of oil. The largest proportion of oil is found in the leaves and flowering tops. In experiments in distilling plants and parts of plants at different times of growth, the author found that the percentage of esters in the oil, which give the oil its fragrant minty odor, increases as the plants approach maturity. The menthol content of the oil bears a close relationship to the ester content. The free acidity and ester content of the oil distilled from dry plants is considerably higher than in the oil from fresh plants. The drying of the plants causes conditions favorable to making esters, while the percentage of free and total menthol in oil produced from dried plants is also uniformly high. It was found also that the formation of esters and menthol takes place most readily in the leaves and tops of the plants.

In another test it was found that the effect of shade upon the peppermint plant is to decrease the making of esters and the formation of menthol. Experiments with plants allowed to freeze indicate that frost noticeably increases esterification and the formation of menthol.

SOME NEW DYES DEVELOPED BY STUDENTS AT RENSSELAER

Achievements of students at the Rensselaer Polytechnic Institue, whose original researches in the dye field are being carried on under the direction of Professor Frederick M. Schwartz, include nineteen new dyes, numbering among them several entirely new shades.

The students have been encouraged to build up the dyes from raw materials, naphthalene, coal tar, etc. Their results include a methyl violet, a shade of lavender closely approaching indigo blue, a series of excellent browns, some yellows from derivations of picric acid, a shade of red derived from naphthol, and a fast black.

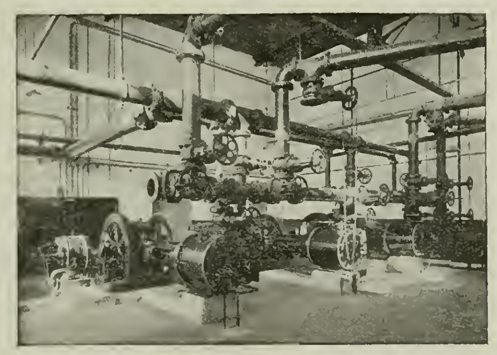
FUMIGATING BALED COTTON

Chemical Control of the Hydrocyanic Acid Gas Process

Since the Revision of the Rules and Regulations Which Govern the Importation of Cotton Lint Into the United States, Effective February 1, 1916, the Fumigation of Imported Cotton Has Become a Live Industry—Among the Companies Organized to Enter This New Field, the Vacuum Company of Massachusetts Was the First to Get Its Plants in Actual Operation, Having One Plant in Somerville, Mass., and Another in Brooklyn, N. Y.

THE object of the disinfection of cotton is to destroy the larvae of the pink boll worm, which is a native of India, the Oriental and Hawaiian Islands. The eggs which it deposits in cotton seeds hatch to life and feed on the seeds for a period as long as seven months. The present cotton disinfecting plants are built to carry out the method of disinfection prescribed by the Horticultural Board of the Department of Agriculture on March 22, 1916. This method, briefly stated, requires that the unmanufactured cotton and cotton waste must be placed in a suitable fumigating chamber where it is subjected to hydrocyanic acid gas under certain definite conditions.

In generating the gas, lumps of cyanide of sodium are placed in a steel basket in the mixing tanks and dissolved in the proper amount of water. This solution is then raised from the mixing tank to the cyanide measuring tank by vacuum. Sulphuric acid is then drawn directly from the carboys, also by vacuum, and the two liquids in the proper proportions are introduced into the generators, where their union causes the formation of hydrocyanic acid. The gas thus formed passes from the generators through cartridges of cyanide of sodium and limestone to absorb completely any free sulphuric acid. It is then drawn into the retorts. After the gas has been used in fumigation it is pumped out of the retorts and passed through a spray washing machine, where it is broken and the cyanide replaced. Two large vats, containing caustic soda solution, are used in connection with this reclamation, one being used until it has been saturated when the process is transferred to the other vat. Continuous circulation is maintained through the spray washer while pumping out the gases.



Portion of Vacuum Company's Plant at Somerville, Mass., Under Chemical Control.

To fumigate the cotton, all bales after being trucked by hand from the freight cars on the sidings to the platform cars, are moved into the retorts and the doors and gates closed. The retorts are then subjected to a vacuum of 25 inches, after which the hydrocyanic gas is introduced until the vacuum is decreased to 5 inches. This condition is maintained for one and a half hours, when the gas is again exhausted to a 25-inch vacuum; then after sufficient washing with air to eliminate any danger of escaping gas the cotton is removed from the retorts, sorted and reloaded on cars for shipment.

In operating the cylindrical retorts the platform cars are loaded alternately from either end, so that while one train of cars is being unloaded and loaded again, another loaded with cotton is in the retort being fumigated. These retorts permit a very efficient and time-saving system of handling. The entire layout of vacuum pumps and piping is such that any combination of pumps and generators may be used on any or all the retorts at one time.

The Brooklyn plant of the vacuum company is operated in the same manner as the one in Somerville, Mass. It is of smaller capacity, containing one rectangular retort 42 feet long. An additional retort and pump are, however, being installed at the present time so that the capacity of the plant will soon be doubled.

Studies, plans and specifications for both Somerville and Brooklyn plants of the vacuum company were prepared by Charles T. Main, engineer, of Boston, Mass. Herbert L. Sherman of the New England Bureau of Tests, Inc., and Arthur D. Little, Inc., acted as consulting chemists.

Bauxite from Georgia.

The Columbia Kaolin and Aluminum Company, of Washington, expects to begin shipments from its bauxite works plant at Gordon, Ga., early in April.

Central Chemical and Supply Co. Organized.

The Central Chemical and Supply Company, of St. Louis, has been incorporated by A. A. Tribble, W. P. Hovy, and John C. Meridith.

GOVERNMENT WOULD STOP FATAL OXYGEN EXPLOSIONS

Careless Methods In Manufacture of Oxygen by Electrolysis Without Frequent Analysis Blamed for Loss of Life

The attention of the Bureau of Mines, Department of the Interior, has recently been directed to a series of explosions of oxygen made by the electrolytic process in which life has been lost. The first of these explosions occurred in Cincinnati, the coroner's jury calling attention to the fact that there were no specifications for the purity of oxygen, and recommended to Col. B. W. Dunn, of the Bureau of Explosives, which bureau publishes regulations regarding the transportation of explosive substances throughout the country, suggesting that that bureau make investigations.

As the Bureau of Explosives did not have any facilities for making such tests Col. Dunn referred the inquiry to the Bureau of Mines, with the request that it investigate the question.

Presence of Hydrogen the Cause.

Active testing was begun, and the preliminary stages of the investigation have recently been completed. In the meantime, there have been many inquiries for information concerning this new danger, and the bureau has explained that it is conducting an investigation and will issue a printed report at the earliest possible moment, and is giving to inquirers certain results, or findings, which it is hoped may be of value, in a precautionary way. Answering a query recently, George S. Rice, chief mining engineer of the bureau, said:

"It is very true that there have been a large number of explosions in various parts of the country of tanks containing oxygen made by the electrolytic process due to the presence of hydrogen mixed with oxygen, and the bureau has been making an investigation of this subject on account of the extensive use of oxygen by mining companies both for welding and cutting purposes, and for use in mine rescue apparatus.

Oxygen Can Be Made Safe for Use.

"In general, the findings of the bureau are these: that strictly speaking there is no spontaneous combustion, but in all cases where sufficient data have been obtained, the oxygen has been used in conjunction with a torch for welding or cutting, and the flame has flashed back through the mixture. It is possible that ignition may occur by a jet of oxygen playing on a carbonaceous material under certain special conditions; nevertheless, these conditions are most unusual, as in many experimental tests made by the bureau the jet could not be so arranged as to cause ignition, although there was a rise of temperature at a certain point and cooling due to expansion at a point beyond."

"In all cases, however, the real danger is in the hydrogen getting into the oxygen, and it has been found that this is due to improper design in the manufacturing apparatus—i. e., the cells and electrical connections; to insufficient safeguards connected with the electric apparatus, the polarity suddently and unexpectedly shifting; to the manufacture of oxygen without frequent analyses, and to incompetent or ignorant attendants.

"Unfortunately certain makers of oxygen manufacturing apparatus have advertised that any laborer can take care of their apparatus. It is believed that the manufacture of electrolytic oxygen can be carried on in a manner to make it entirely safe. In fact, there has to be over 9 per cent. of hydrogen with the oxygen to make an explosive mixture. Nevertheless, certain tanks from one batch caused three widely separated explosions in California, killing seven men in all, and an analysis of gas from a tank filled at the same time showed that it contained over 50 per cent. of hydrogen."

CHEMISTS STOP LOSSES IN THE COAL MINING INDUSTRY

Very excellent economic reasons for the employment of a chemist in connection with the washing of coal as practiced in the coal mining industry are given by Edward H. Coxe, of Knoxville, Tenn., in a letter to the secretary of the American Institute of Mining Engineers.

"Efficient coal washing, and especially of the finer sizes," says Mr. Coxe, "can be accomplished only under the supervision of a chemist, as the proper regulation of the washer can only be had by frequent sampling and analysis of the raw and washed product and the refuse, say, at least semi-weekly: and only in this way can a check be kept on the quality of the product and the amount of good coal wasted in the refuse.

"In large operations, frequently enough coal can be saved from going to the refuse pile to more than pay the salary of the chemist."

Kalbefleisch Factory Near Completion.

Work on the construction of a large chemical plant at Chattanooga, Tenn., has been almost completed by the Kalbefleisch Corporation. The site of the factory covers thirty-two acres on "Moccasin Bend" of the Tennessee River in North Chattanooga. The corporation will manufacture paper makers' alum and sulphate of alumina at the rate of 24,000,000 pounds per annum.

Iridescent Dyes Increase Capital.

The Iridescent Dyestuff and Color Co., of Brooklyn, N. Y., has announced an increase in its capital stock from $25,000 to $50,000.

DISTILLATES

News Notes of Chemical and Allied Industries

Peru Will Import Quinine.

In preparation for a campaign against malarial conditions in that country the Peruvian Government has made arrangements to import annually such quantity of quinine as may be considered necessary. This drug will enter the country free of all customs duties and port charges and will be sold to the inhabitants by the government at cost price.

Potash Corporation Organized.

The National Potash Corporation, of Rochester, potash, chemicals, etc., has been incorporated under the laws of New York with a capital stock of $25,000 by H. N. Dons, W. A. Delongue and T. J. Morrison, Rochester.

Medical Importations.

The American Medical Import Company, of Brooklyn, has been incorporated under the laws of New York with a capital of $50,000. The incorporators are M. Gollobin, H. L. Gross and H. Ginsberg.

A Call for Cheaper Potash.

Shortage of potash at a reasonable price has caused C. Dorflinger & Sons, manufacturers of cut glass at 36 Murray Street, New York, to announce their temporary inability to make any more glass blanks for cutting until a cheaper supply is obtainable.

Dyestuff and Chemical Warehouse.

The Central Dyestuff and Chemical Company has awarded a contract for the erection, at a cost of $80,000, of a warehouse at Newark, N. J., near the New Jersey Central Railroad.

Vanillin Desired in Spain.

Pure crystallized vanillin, on which payment will be made in advance, is desired by a chocolate manufacturer in Spain, according to a press report.

New Chemical Manufacturer.

A new concern for the manufacture of chemicals, to be known as the Punch Products Company, has been incorporated under the laws of Delaware by Arthur W. Britton, Samuel B. Howard, and L. H. Gunther, New York.

Glue, Gums and Saccharine.

The Talbot Manufacturing Company, of Manhattan, glue, gums, saccharine, etc., has been incorporated under the laws of New York with a capital stock of $10,000.

$172,000,000 Invested in Dyes.

According to figures compiled by the Journal of Commerce, capital stock authorized in the incorporation of new companies for the manufacture of dyes, colors and chemicals from the first of 1915 to February, 1917, aggregated $172,289,000, while in February alone the stock of new dye and chemical concerns was $3,900,000, against $3,550,000 in the preceding month.

Soaps and Chemicals.

The Sanolene Co., Inc., of Rochester, chemicals, disinfectants, soaps, etc., has been incorporated under the laws of New York by J. A. Hotchkiss, S. D. Radcliffe and G. W. Heath, 249 Elm Street, Rochester.

William A. Flynn Moves to New York.

T. A. Flynn & Son Company, Inc., of Wilmington, Del., chemicals, tanners' supplies, etc., have announced the appointment of William A. Flynn as the New York representative of the firm.

Union Laboratory Incorporates.

Union Laboratory, Inc., of Binghamton, drugs, has been incorporated under the laws of New York by A. Packovich, H. Schrott and M. Lundin.

Salol and Salicylates.

Salol and salicylates are being made in considerable quantities at the new factories of the Russian Chemical Company, as well as naphthol, Glauber's salt and chemically pure soda and ammonia.

New Brooklyn Chemical Company.

Announcement is made of the incorporation under the laws of the State of New York of the Crossley Chemical Co., Brooklyn, with a capital stock of $40,000. The incorporators are H. B. Deyo, E. D. Loughman and C. H. Bailey.

F. C. Schapper Retires.

Following the retirement of F. C. Schapper, for thirty-two years Chicago representative of the Roessler & Hasslacher Chemical Company, Alfred C. Stepan, formerly of the New York office, has assumed sole charge of the Chicago sales office.

Potash and By-Products.

Potash and by-products will be manufactured by the Charlestown Chemical Company, of Charlestown, Tenn., which has been recently incorporated by A. L. Kirkpatrick, Melvin J. Shyer, Oscar C Schwarzenburg and others.

MARCH PRICES OF CHEMICALS, ETC.

The New York Wholesale Market on March 7

Acids.

ACETIC—100Lbs.		
28 per cwt	3.50	@3.65
56 per cwt	7.00	@7.15
Glacial	.25	@ .30
ACETYLSALICYLIC—		
Bulk	3.55	@3.60
Ounces	.24	@ .26
AQUA FORTIS—Lb.		
36 deg	.05¼	@ .05½
38 deg	.05½	@ .05¾
40 deg	.06	@ .06¼
42 deg	.06¼	@ .06½
BENZOIC Lb.		
Ex. gum	...	@ ...
Ex. Toluol	8.00	@8.25
Camphoric	4.40	@4.50
BORACIC—		
Crystals	.13¼	@ .13½
Pow'd	.13	@ .13½
CARBOLIC—Per Lb.		
Drugs	.45	@ .48
1-lb. bott	.58	@ .59
5-lb. bott	.56	@ .57
Cans	.52	@ .55
Liquid	.47	@ .50
CHROMIC—		
Technical	1.20	@1.25
U. S. P.	1.25	@1.50
CITRIC—		
Crystals	.72	@ .75
Pow'd	.72½	@ .75
CRESYLIC—Gal.		
95 per cwt	.75	@ .77½
30 per cwt	.23	@ .25
Formic, 75%	...	@ ...
Gallic	1.30	@1.32
Hydrocyanic, dilut, 3%	.20	@ .22
HYDROFLUORIC—Lb.		
30 deg	.05	@ .05½
48 deg	.08½	@ .09
52 deg	.10	@ .10½
LACTIC—Lb.		
Pure, 50%	.30	@ ..
Tech, 50%	.09	@ ..
Tech, 22%	.04½	@ ..
MURIATIC—100 Lbs.		
18 deg	1.50	@1.75
20 deg	1.75	@2.00
22 deg	2.00	@2.25
NITRIC—Lb.		
36 deg	.05½	@ .05¾
38 deg	.05¾	@ .06
40 deg	.06	@ .06¼
42 deg	.06¼	@ .06½
Oleum	40.00	@ ...
OXALIC—		
Crystals	.46	@ .48
Pow'd	.48	@ .50
PHOSPHORIC—		
50 per cwt	.20	@ .22
85 per cwt	.29½	@ .30
87½ per cwt	.30	@ .30½
*Picric	.75	@ .85
PYROGALLIC—		
Resublim	3.52	@3.45
PYROLIGNEOUS—		
Tech, gal	.10½	@ .13½
Pure, lb	.05	@ .05½
Salicylic	.80	@ .85
SULPHURIC—100 Lbs.		
60 deg	1.00	@1.25
66 deg	1.50	@1.75
Sulphurous	.03	@ .05
TANNIC—		
U. S. P.	.90	@1.06
Technical	.65	@ .70
TARTARIC—		
Crystals	.76	@ .85
Pow'd	.75	@ .82

---

*Nominal.

Chemicals.

ACET. LIME—100 Lbs.		
Gray	3.50	@3.55
Acetone	.22½	@ 23
ALUM-AMMONIA—		
Lump	.04	@ ...
Ground	4.20	@4.25
Pow'd	.04⅝	@ .04¾
Burnt	.09½	@ .10
ALUM POTASH—		
Lump	.05½	@ .06½
Ground	.06¾	@ .07
Pow'd	.06¼	@ .06½
Burnt	.12	@ .16¾
ALUMINA SULPH.—		
Technical	.03½	@ .04
Iron free	.05	@ .05½
AMMONIA AQUA—Lb.		
16 deg	.02¾	@ .03¼
26 deg	.06	@ .06¼
AMMONIA CARB.—		
Casks	.09⅛	@ .09½
Barrels	.09½	@ .10
*ANTIMONY—		
Salt, 75%		@ ...
Needles	..	@ .
Oxide	...	@ ...
Pow'd	.18	@ .20
Argols	.10	@ .10½
*ARSENIC—		
White	.12	@ .13
Red	.25	@ .28
ARS. OF LEAD—		
Pulp	.09	@ .09½
Pow'd	.21	@ .22
*BARIUM—		
Chloride	90.00	@95.00
Nitrate	.11½	@ .13
Benzol	.55	@ .60
BLANC FIXE—		
Paste	.03	@ .03½
Powder	.04	@ .04½
*BLUE VITRIOL—		
Carloads	.09½	@ .10
Jobbing	.10	@ .10¼
Pow'd	.13½	@ .14
BORAX—		
Pow'd, bbl	.07¼	@ [illegible]
Crys, bgs	.07¼	@ .08
Crys, bbls	.07¼	@ .08
Brimstone, ton	45.00	@
CALCIUM—		
Peroxide	1.[illegible]	@
Sulphate	.10	@ [illegible]
CARBON—		
Bisulph	.05½	@ .06½
Tetrachlor	.16½	@ .17
CHLORIDE LIME—		
Drums	.03½	@ .04
Casks	.04½	@ .05
Perchlor	.17	@ .18
Sulphide	...	@ ...
*MANGANESE—		
Borate	.36	@ .39
Chlorate	...	@ ...
Sulphate	...	@ ...
NICKEL SALT—		
Single	.11	@ .11½
Double	.08	@ .08½
PEROXIDE OF HYDROGEN—	Gross.	
¼ lb. bot	6.50	@ ...
½ lb. bot	10.25	@ ...
1 lb. bot	18.00	@ ...
*POTASH Per Lb.		
Bicarb	1.25	@1.40
Bichrom	.38	@ .40
Perm'ate	3.50	@3.65
Clorate—		
Crystals	.63	@ .65
Pow'd	.63	@ .65
Granular	.82	@ .83
Prus. yel	.90	@ .92½
Prus. red	2.50	@2.75
Caustic	.78	@ .90
*Cyanide—		
True	2.25	@2.50
Mixture	1.90	@2.00
1st sorts	.18	@ .19
Roch. salt	.36½	@ .37
SAL AMMONIAC—		
Lump	.17	@ .18
Gran, wh	.17½	@ .18
Gran, gr	.09	@ .10
Pow'd	.20	@ .21
SALTPETER Per Lb.		
Crystals	.35	@ .35½
Granular	.31	@ .32
Pow'd	.31¼	@ .32
Commerc'l		@
*SODA—Per Lb.		
Ash—		
Light	2.95	@3.12½
Dense	3.35	@3.33½
Bicarb	.02	@ .03½
Caustic, 76%	.04¼	@ .04¾
Bichrom	.17	@ .18
Benzoate	8.00	@ 8.25
Acetate	.10	@ .11
Nitrite	.18	@ .20
Phosphate	.05	@ .06
Prussiate	.33	@ .35
Chlorate	.25	@ .26
Sal	1.10	@ 1.25
Salicylate	.85	@ .90
Hyposulph	.01¾	@ .02¼
Silicate	1.00	@1.10
Sulphide	.02	@ .02½
Cyanide	1.30	@1.35
Solvent-naphtha	.25	@
Cases	.07	@ .08
Copperas	1.15	@1.25
COBALT—		
Metal, oz.	32	@ ...
Acetate, lb.	.95	@ ...
Oxide	...	@1.30
Sulphate	...	@ .50
COPPER—		
Carbonate	.45	@ ...
Nitrate	.45	@ .50
CREAM TARTAR—Lb.		
Crystals	.45½	@ .48
Pow'd	45	@ ...
EPSOM SALT—		
Bags	3.00	@3.25
Barrels	3.00	@3.25
Technical	3.00	@ ...
FORMALDEHYDE—		
Barrels	.12½	@ .13
Carboys	.12½	@ .13
Glaub. salt, per 100 lbs.	.75	@ .85
IRON—		
Oxide	.13	@ .15
Strontia, nit	.28	@ .30
SUG. OF LEAD—Lb.		
Brown	.12⅛	@ ..
White—		
Broken	.13¼	@ ...
Crystals	.14	@ ...
Pow'd	.14¾	@ ...
SULPHUR—100 Lbs.		
Flour	2.35	@2.75
Flowers	2.75	@2.95
Roll	2.20	@2.50
Commerc'l	1.60	@1.70
TIN—		
Bichloride	.16½	@ .17
Crystals	.33½	@ .34
Oxide	.54	@ .56
TOLUOL—Gal.		
Commerc'l	1.75	@ ...
Pure	2.00	@ ...
*ZINC—		
Carbonate	.25	@ .27
Chloride	.10¼	@ .11½
Oxide	.12	@ .14
Sulphate	.06½	@ .07

---

*Nominal.

Dyestuffs.

ANNATTO—Per Lb.		
Cans	.32	@ .33
Rolls	.33	@ .34
Annatoine	.85	@ ..
ANILINE—		
Salt	.31	@ .38
Oil	.28	@ .32
ALBUMEN—		
Blood	.40	@ .45
Egg	.82	@ .83
Egg yolk	.32	@ ...
*BETA NAPHTOL—		
Sublimed	.90	@1.00
Commerc'l	.75	@ .85
Carmine, No. 40	4.50	@4.70
COCHINEAL—		
Black	.52	@ .53
Silver	51	@ .52
Pow'd	.59	@ .60
Cudbear	.25	@ .27
CUTCH—		
Cases	.10½	@ .11½
Mats	.10	@ .11
Pow'd	.15	@ .18
DEXTRINE—100 Lbs.		
Regular	4.40	@4.49
Canary, dark	4.55	@4.64
Gum	4.80	@4.89
*DIRECT—		
Black	1.75	@2.10
Brown	2.75	@3.75
*Divi divi, per ton	50.00	@52.00
Gambier	.13½	@ .14½
HEMATINE—		
Crystals	.24	@ .28
Extract	.14	@ .20
*INDIGO—		
Madras	1.10	@ ...
Manila	1.37	@1.38
Bengal	3.95	@4.00
Pow'd	1.20	@
Guatemala	2.55	@ ..
*LOGWOOD—		
Logs	30.00	@35.00
Chips	.02¾	@ .03½
Extract	.11	@ .15
Madder D.	.24	@ .25
Myrobolans	40.00	@45.00
*NIGROSINE—		
Water sol	.90	@1.25
Spirit sol	.75	@ .90
*NUTGALLS—		
Aleppo	.65	@ ...
Ground	.65	@ ...
Pow'd	.65	@ ...
China	...	@ ...
OAK BARK—		
Red	.08	@ .09
White	.08	@ .09
Orchil liq	.30	@ .45
Paranitraniline	1.35	@1.45
Quebracho	..	@ ...
SOLUBLE BLUE—		
Powder	.80	@ .85
Paste	.34	@ .36
*SULPHUR—		
Black	.60	@ .90
Brown	.25	@ .50
Sumac	90.00	@ ...
Turkey Red Oil, 50%	.09	@ .10
TURMERIC—		
Aleppo	.09¾	@ .10
Madras	.08½	@ .09
China	.07	@ .08
Pubna	...	@ ...
Pow'd	.08½	@ .09¾
Zinc dust, lb	.22	@ .28
*CHIPPED DYEWOOD—		
R. Sanders	.12	@ .11
Barw'd, lb	.06	@ .08
Camwood	.18	@ .20
Fustic	.07	@ .08

---

*Nominal.

Essential Oils.

ALMOND Per Lb.		
Bitter	14.00	@16.00
Artificial	5.00	@5.25
Sw't true	.80	@ .85
Peach ker	.34	@ .37½
CITRONELLA—		
Drums	.49	@ .50
Cans	.50	@ .51
CLOVES—		
Cans	1.40	@1.45
Bottles	1.45	@1.50
Copaiba	.85	@1.00
Coriander	9.75	@10.00
Croton	.85	@ .90
Cubeb	4.75	@5.00
Cummin	4.25	@4.30
Dill	4.25	@4.50
Erigeron	.95	@1.00
EUCALYPTUS—		
American	.62½	@ .65
Australian	.70	@ .75
Fennel	3.75	@4.00
JUNIPER—		
Berries	13.00	@17.00
Wood	1.50	@1.65
LAVENDER—		
Flowers	3.75	@4.50
Garden	.60	@ .65
Spike	.80	@ .85
PENNYROYAL—		
American	1.65	@1.85
Foreign	1.10	@1.25
PEPPERMINT—		
Tin	2.20	@2.30
Cases	2.85	@ ..
ROSE Per Oz		
Natural	13.50	@16.00
Synthetic	2.75	@3.00
SASSAFRAS—		
Natural	.65	@ .75
Artificial	.28	@ .35
Savin	6.50	@ ..
Spearmint	1.75	@1.90
Spruce	.60	@
Terpinol	.65	@ .75
THYME—		
White	1.25	@1.40
Red	1.20	@1.30
Tansey	2.15	@2.20
WINTERGREEN—		
Leaf	3.85	@4.00
Sw't birch	2.25	@2.35
Synthetic	.85	@ .90
Wormwood	2.75	@3.00
Worms'd	4.00	@4.25
Yyang yl'g	20.00	@60.00
Manila	20.00	@60.00
Bourbon	10.00	@15.00

---

*Nominal owing to scarcity.

THE CHEMICAL ENGINEER

VOL. XXV. APRIL, 1917 No. 2

Published Monthly by the

McCready Publishing Company.

ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

LAURANCE T. CLARK, Editor

CHARLES B. DAVIS, F. C. S., Consulting Editor

Application made for entry as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, APRIL, 1917.

Government Tests of Gasolines: Physical and Chemical Properties of Many Varieties Sold Throughout the United States During 1915 .. 42
W. F. Rittman, W. A. Jacobs and E. W. Dean.

Ultra Violet Light: Its Application in Chemical Arts. Part II 54
Carleton Ellis and A. A. Wells.

The Commercial Development of Technical Businesses 59
George H. Gibson.

Some Technochemical Problems of Today 62
Dr. Raymond F. Bacon.

Conversion of Barium and Radium to Carbonates at Low Temperature 66

Shortage of Ammonium Sulphate for Japanese .. 66

A New Flotation Oil, and a New Source of Flotative Agents 67
Oliver C. Ralston.

Japanese and American Oils in South China 68

Comparative Tests with Mangrove and Wattle Barks 69
F. A. Coombs, F. Alcock and A. Stelling

Clothing from Peat Fiber on Large Scale 73

High Extractions from Lead Ores of Low Grade .. 74

Tennis Star Becomes Industrial Chemist 74

The Development of American Dyes 75
Myron Drew Reeser.

Chemical Investigation, Efficiency and Control ... 77
Conducted by Charles B. Davis.

Distillates: News Notes of Chemical and Allied Industries 78

Foreign Trade Opportunities: Information Concerning Markets Abroad for American Manufacturers 79

April Prices of Chemicals 80

THE AMERICAN CHEMIST MUST ENLIST.

The tocsin has been sounded, and now as never before must the resources of America be collected and concentrated along certain definite lines which will transform their vast potentialities into tangible accomplishments. Industrial and scientific forces of a magnitude scarcely comprehended by the average individual are being set in motion to bring about a great number of widely diversified, yet correlated, results. Each of these results, in the months to come, will contribute its share toward the achievement of the common aim—complete national preparedness for aggression and defence.

The desire to do one's "bit" is universal, and for this reason the development of our national stamina and power is not a question of the existence of these forces, but rather one of their intelligent application.

Such a force is the American chemist. The importance of his part in the governmental scheme of universal service is obvious. His whole-hearted efforts are needed urgently, and he must be ready to give them without hesitation.

Thousands of men will be called upon to man our warships, and thousands more will likewise be summoned to bear our arms afield, but it is not the purpose of the government at present to utilize him in any of these ways.

The place for the American chemist just now is in a laboratory engaged in furthering the ends of the United States Government, and to this task he must give his best energies and abilities. Let no mistaken sense of duty, therefore, send him hastening to the nearest recruiting station, for such would not be the most intelligent application of the force which he represents. But by all means let him send his name at once to be enrolled among those upon whom the government can call, and then let him be ready to submit his talents and training to the direction of our leaders at a moment's notice. It is in this way, and in this way alone, that he can be sure he is serving his flag to the best of his ability.

GOVERNMENT TESTS OF GASOLINES

Physical and Chemical Properties of Many Varieties Sold Throughout the United States During 1915

By

W. F. Rittman, W. A. Jacobs and E. W. Dean.[*]

The Bureau of Mines, In the Course of Its Petroleum Investigations, Has Noted the Dearth of Published Information Regarding the Physical and Chemical Properties of Different Varieties of Gasoline Generally Marketed. Such information Is of Great Importance Both to Producers and Consumers, and for this Reason It Was Deemed Advisable to Conduct an Investigation To Determine the Properties of Gasoline Sold Throughout the United States During 1915. The Results of This Investigation Are Reported in This Paper.

Definition of Gasoline.

Gasoline has been defined in one of the standard dictionaries as "a highly volatile mixture of fluid hydrocarbons, obtained from petroleum; also by distillation of bituminous coal." The present work might well have been suggested by an attempt to make this definition more nearly complete and up-to-date. The definition is fairly adequate with regard to the source of gasoline, needing only to be extended so that it includes products extracted from natural gas by processes of compression or washing. The definition of the properties of gasoline is both comprehensive and indefinite. "Highly volatile" has no exact meaning when interpreted in degrees of temperature for boiling point or millimeters of mercury for vapor pressure. Also, the definition given does not indicate the uses of gasoline.

For the purposes of this report it is not necessary to discuss the sources and origin of gasoline, nor is there much interest at present in any use but one, which is as fuel for internal-combustion engines. The matter of chief importance is the definition of properties, which, as superficial consideration shows, introduce so many complications that a few words or even a few sentences are not adequate.

Need of Information Regarding Properties of Gasoline.

Gasoline is now of such great commercial importance that adequate information regarding its physical and chemical properties should be furnished the public. The testing of gasoline for these properties is by no means novel or original, but in the past it seems to have been limited to refinery laboratories, and the refiners have not deemed it desirable to publish the information that they possess. Detailed descriptions of the properties of products have not, apparently, appealed to them as good advertising literature. To the author's knowledge no advertisement has ever stated, for example, that a gasoline had an "iodine number" less than 6, or that 80 per cent. of the gasoline would distil between temperature limits of 50° and 125° C., nor has any attempt been made to educate the public with regard to the advantages and disadvantages of low iodine numbers and narrow ranges of volatility. The common variety of advertisement usually states that the wise user gets more power out of the brand of gasoline sold by the advertiser, or that carbon troubles are eliminated, or that "it puts life in the motor," and so on.

Automobile users sometimes try to keep a check on the number of miles their cars will run on given quantities of gasoline, and they also note relative ease of starting and freedom from carbon deposition in the cylinders of the motor. The specific gravity and odor are properties commonly considered in judging the commercial value of a gasoline and a drying test is sometimes performed to determine whether the gasoline is admixed with kerosene.

Types of Gasoline Sold in the Market.

In considering the commercial types of gasoline consideration must be given chiefly to methods of refining and production. The differences existing may be roughly divided as follows: (1) Variations due to grading according to specific gravity; (2) variations due to the source of the original crude oil, as the eastern fields, the Mid-Continent fields, and California; and (3) variations due to processes of production, as "straight" refinery products, blended casing-head gasoline, and gasoline produced by cracking processes.

Variations due to specific gravity need little discussion. It has been the accepted practice in the East for refiners to put out several grades of gasoline and naphtha, these products being differentiated according to their specific gravities. The highest-priced grade, called "76°" gasoline, is as light as is practicable to use, dangers in handling and evaporation losses being considered. Such gasoline really has a specific gravity of 73 to 74° B., the 76° figure being a trade rating which is not attained in actual practice. The other and cheaper grades of gasoline are sometimes rated according to gravity and are sometimes classed as "auto" or "motor" gasoline. Grading according to specific gravity was of some significance in the past, but now means nothing unless information is at hand regarding several other details. Of these the source of the crude oil from which the gasoline was produced is important. Gasoline from the Mid-Continent and western fields is more volatile for a given specific gravity than that produced from eastern crudes. Another factor of even greater importance than source is the method of production. Recently there has come on the market a product that is known as casing-head gasoline and is produced from certain varieties of natural gas by compression and condensation, or by washing with heavy oils and subsequently distilling the gasoline from the saturated wash oil. "Straight" casing-head gasoline is much more volatile than the ordinary refinery product and must be treated with some care both in handling and storage. It is not usually kept long in its original condition, but is generally marketed in the form of a blend with heavy naphtha or light kerosene. Such a blended gasoline may be of any gravity desired by the producer, but it is naturally different in composition and properties from the straight refinery product it may chance to resemble superficially. This is due to the fact that the blend is generally composed of hydrocarbons both lighter and heavier than those found in the "straight" refinery product.

---

[*] Extracts from a Technical Paper issued by the Bureau of Mines.

Still another possibility of variation is that due to the presence on the market of large quantities of what is termed cracked gasoline, made by the thermal decomposition, under pressure, of heavier hydrocarbons. These "cracked" gasolines always contain considerable percentages of unsaturated constituents, and may in some cases require that they be used under engine conditions different from those favorable for straight refinery products. Unsaturated compounds have certain characteristic chemical properties. Of these the ones of importance in the present connection are the powers of reaction with sulphuric acid and with iodine. The latter property, iodine absorption, is of use in the laboratory determination of degree of unsaturation.

Specific Gravity Tests.

Specific gravity measurements are made by the displacement method, an ordinary Westphal balance equipped with a special small plummet being used. This plummet proved decidedly convenient for testing quantities of liquid as small as 6 to 8 c.c. It is used with ordinary weights, according to the scheme outlined by Weiss.* Such a plummet may be constructed by anyone having elementary skill in the art of glass working. The method is as follows:

A piece of ordinary glass tubing of about 7 mm. outside diameter is sealed at one end with a short platinum wire melted into the glass where sealed. This tube is allowed to cool and about 9 to 10 grams of mercury placed in it, making a column about 35 to 40 mm. high. The tube is then cut off to within 20 mm. of the top of the mercury and sealed off with a blowpipe flame. The plummet when completed is about 55 to 60 mm. long and should have a weight of 10 to 12 grams.

Specific gravities were determined from ordinary weighings with a Westphal balance by calculation according to the formula given below.

$$\text{Specific gravity of oil} = \frac{c - a}{b - a}$$

a = the weight required to balance plummet in air.
b = the weight required to balance plummet in water.
c = the weight required to balance plummet in oil.

It may be noted that although in tabulating the results Baumé equivalents for specific gravities are recorded, the use of the Baumé scale is most heartily deplored. A full discussion of the disadvantages of this system of measuring density would be both lengthy and useless, and attention is called only to the fact that in using Baumé degrees the particular system employed should be known and stated. At least three systems are known by the authors to have more or less acceptance for liquids lighter than water. The general relation between Baumé degrees and specific gravity is expressed as follows:

$$\text{Specific gravity} = \frac{\text{Modulus}}{(\text{Modulus} - 10) + \text{degrees Baumé}}$$

The modulus 140 is approved by the Bureau of Standards and was employed in the work described herein. The modulus 141.5 is that adopted by one of the large instrument makers of this country, and is perhaps the one most largely used by oil men.

It is to be hoped that oil men will abandon this unreliable and illogical system of measuring density and resort to the more definite and simple system of specific gravity measured in decimal units. Because of the various moduli employed it is recommended that in reporting in terms of degrees Baumé care be taken to specify the particular modulus used. If the modulus is unknown, it may be of help to specify the name of the maker of the instrument used. The need of this precaution has already begun to receive recognition, and a sample of fuel oil recently sent to the bureau was accompanied by the following statement: "Baumé gravity (Tagliabue's) at 60° F., 16.2°."

Distillations.

In the distillation methods generally employed for the testing of gasoline a simple flask of the Engler type is used, and the results obtained are reasonably satisfactory for technical purposes, as all that is desired is a uniform basis of comparison for different samples. In the present experiments, however, it was thought desirable to obtain a greater degree of efficiency in fractionation, and therefore the method employed was one that a recent series of experiments* proved to be most desirable for the examination of crude petroleum.

---

*Weiss, J. M., Specific Gravity, its determination for tars, oils, and pitches. Jour. Ind. and Eng. Chem., vol. 7, Jan., 1915, pp. 21-24.

*Rittman, W. F., and Dean, E. W., The analytical distillation of petroleum: Bull. 125, Bureau of Mines, 1916, 79 pp.

The procedure employed was as follows: The distilling flask, having a bulb of 300 c.c. capacity and a column measuring 1 inch in internal diameter, 6.5 inches from bulb to outlet and 2 inches from outlet to top, was placed on a balance, and supported in an upright position by a cardboard box that contained a device for supporting the fractionating column and a quantity of aluminum beads. The flask and accessories were counterpoised and a 200-gram sample of gasoline weighed in. The supporting device was then inserted and beads enough poured in to form a compact column 5 inches high. The box, with the rest of the beads and the counterpoising weight, was set aside, so that at the end of the distillation the residue remaining in the flask could be determined.

The filled flask was then set up with an electric heater and a vertical condenser, the latter being a three-bulbed tube surrounded by a metal jacket containing cracked ice and water. The distilling flask was equipped with an accurate and sensitive thermometer. The distillates were collected in test tubes, the weights of which had been determined and marked on the glass.

The distillation was conducted at a uniform rate of about two drops a second, the tubes in which the distillates were collected being placed under the condenser in a vessel which contained cracked ice. The tubes and their contents were weighed immediately after the completion of each fraction, corked, and set aside in an ice bath for the determination of specific gravity.

After a distillation was completed the cooled flask was again placed upon the balance and the weight of the residue determined. The amount was added to the sum of the fractions and the result subtracted from the original weight of the charge, thus giving a measure of the loss incident to distillation. This procedure also furnished an excellent check upon errors of weighing and computing. If the loss was abnormally large, or if there was a gain instead of a loss, the presence of an error was immediately indicated.

The method of determining percentages by weight instead of by volume is not in common use among petroleum technologists in this country, and might be considered disadvantageous on account of the fact that commercial transactions in this country are conducted on the basis of volume. For scientific work, however, the advantage of working in terms of weight is considerable. In the first place, weight is more easily determined with proper accuracy than is volume, provided care is taken in weighing and marking tubes and equipping a balance with some convenient supporting device. In the second place, the weight of any given quantity of liquid is constant and independent of temperature, whereas the volume varies with the temperature. Finally, weighing permits easy and accurate determination of the residue left in the flask.

As specific gravity determinations were made for all the cuts, it is a simple matter to recalculate the weight percentages into terms of volume in case a need arises for such information. For the purpose of this report it has not seemed necessary to make these recalculations.

It is to be noted that the method employed does not use the conventional "end point," but employs rather the measurement of residue left after a temperature limit is reached and the quantity of distillate in the flask is relatively small. The temperature limit is, however, approximately an end point and may conveniently be considered such if a high degree of accuracy is not desired in making comparisons with the more general method.

Evaporation Losses.

Evaporation losses were determined by an empirical method which roughly paralleled conditions that cause losses in the commercial handling of petroleum products.

The procedure adopted was as follows: A 25-gram quantity of gasoline was placed in a tube made by cutting off the constricted top of an ordinary 2-ounce oil sample bottle. This open-topped tube with its contents was placed in a bath at a temperature of 20° C. and kept there for an hour. Then the tube and contents were weighed and the percentage loss calculated.

Although the results by this method are without significance on an absolute basis, in that they do not even approximately show the probable amount of loss under commercial conditions, they serve well for comparing the various samples and show the relative possibilities of loss through evaporation.

Determination of the Content of Unsaturated Hydrocarbons—Sulphonation Method.

The sulphuric acid absorption method does not give satisfactory results when applied to "straight" refinery gasolines, the general result being merely a discoloration of the acid. On this account the test was made only with such samples as had iodine numbers sufficiently high to indicate the presence of cracked products.

The procedure adopted was simple, although neither rapid nor accurate. In a 50-c.c. tube, graduated in fifths of a cubic centimeter, there were placed 20 c.c. of the gasoline and 20 c.c. of ordinary sulphuric acid having a specific gravity of 1.84, indicating a purity of 94 per cent. The two liquids were shaken together thoroughly and allowed to stand over night or until a clear-cut separation was obtained. The decrease in volume of gasoline was then read, the decrease being equivalent to the content of unsaturated compounds.

The method was undesirable in several ways, and experiments have been conducted more recently in the Bureau of Mines laboratory with a view to improving it. For the present it may be stated that the figures given in this report are of value only in showing roughly the percentage of the various products that might be removed by treatment with a sufficient quantity of sulphuric acid.

Determination of Iodine Numbers.

A particularly satisfactory and sensitive method of differentiating gasolines with regard to their content of unsaturated hydrocarbons is the determination of iodine numbers. Iodine numbers, of course, represent only approximately the theoretical iodine absorption, as they are dependent on conditions of temperature and concentration and on the nature of the reaction. It is, therefore, necessary in giving iodine numbers to specify the conditions under which they were measured. For purposes of comparison, however, the determination of iodine numbers is of great advantage. The measurements can be made with ease and accuracy, and the differences for varying saturation percentages are great because the molecular weight of iodine is high and each unsaturated bond of the hydrocarbon absorbs two atoms.

In the work described in this report Hunt's modification of the method of Hanus was used. This is described in a recent paper by Smith and Tuttle.*

A 30-minute absorption period is recommended, and the quantities of oil and iodine should be so adjusted that at the end of the reaction 70 to 90 per cent. of the iodine remains unabsorbed.

The procedure adopted may be outlined briefly as follows:

A quantity of gasoline, generally varying from 0.04 to 0.20 gram, was measured from a capillary pipette into an iodine absorption flask containing 10 c.c. of chloroform or carbon tetrachloride. Ten c.c. of Hanus solution, prepared by dissolving 13.2 grams of iodine and 3 c.c. of bromine in a liter of glacial acetic acid, was added, and the flask was stoppered and set aside in the dark for 30 minutes. At the end of this time 25 c.c. of 10 per cent. potassium iodide solution was poured in and then 100 c.c. of distilled water was added. The excess of iodine was determined by titration with sodium thiosulphate solution, prepared by dissolving about 25 grams of sodium thiosulphate to the liter and standardizing against iodine liberated by a standard potassium dichromate solution.

The iodine number is the percentage by weight of iodine absorbed. It is calculated by the following procedure: The titre of an unknown is subtracted from that of a blank (Hanus solution and chloroform or carbon tetrachloride allowed to stand 30 minutes without any gasoline), and the difference in cubic centimeters of thiosulphate solution is multiplied by the weight of iodine equivalent to each cubic centimeter of the solution. The weight of iodine thus found is divided by the weight of gasoline taken and multiplied by 100, giving the iodine number.

Determination of Calorific Value.

The calorific value of a number of the gasolines was determined with a bomb calorimeter of the Dinsmore-Atwater type. The procedure employed was the same as that normally employed for determining the calorific value of oils, except that on account of the volatile character of gasoline it was necessary to adopt special precautions in weighing out the samples. The gasoline was placed in a gelatin capsule, the calorific value of which had been previously determined, and a correction made for the quantity of gelatin burned in the determination.

Sulphur Determinations.

The sulphur content of the gasoline was determined in a number of instances by precipitating the sulphur with barium chloride from the bomb liquors and weighing the sulphate. A correction was applied for the sulphur contained in the gelatin capsules.

Engine Tests.

The engine tests run in connection with the present study were made possible through the kindness of Messrs. C. F. Kettering and J. H. Hunt, of the Dayton Engineering Laboratories Co., of Dayton, Ohio, who placed at the disposal of the Bureau of Mines their highly developed equipment, which is undoubtedly as accurate and reliable as any yet used. The results obtained show certain inaccuracies which were largely due to the inability of the Bureau of Engineers to furnish samples of gasoline large enough to permit adequately long runs and the duplication of runs. The results, however, were adequate for the purposes of this report.

Method of Conducting Tests.

Tests were made of the brake horsepower developed in an automobile engine when like amounts of gasoline were run through the carburetor. The conditions of operation were as follows:

The gasoline was tested by running an L-head, six-cylinder motor, with 3½ by 5 inch cylinder, on wide-open throttle at 1,000 revolutions per minute, the output being measured by means of a Sprague electric dynamometer.

The speed was measured by means of a Hoskins electric tachometer and did not vary over 1.5 per cent. fast or slow during any run.

The outlet water from the cylinders was kept at a temperature of 140° to 150° F. (60° to 65.5° C.) during each run, the temperature being measured by an ordinary mercury thermometer set into an oil well at the bend in the outlet line.

The carburetor was adjusted to give the best engine torque obtainable when using the ordinary grade of gasoline sold in Dayton, Ohio. The adjustment was not changed thereafter during the series of runs.

A three-way valve was connected in the line at the carburetor, and after the engine had been running on ordinary gasoline long enough to bring the water to the proper temperature, the test gasoline was turned in. After the engine had run long enough to insure that the carburetor float chamber was filled with the test fuel, a run was made on one pound of this fuel, the beginning and end of the run being indicated by an electric bell controlled by the beam scale, and the time being taken with a stop watch.

---

*Smith, W. H., and Tuttle, J. B., Iodine numbers of linseed and petroleum oils; Bureau of Standards Tech. Paper 37, 1914, pp. 1-17.

The spark position was maintained constant during the run, being placed at the point that gave the best torque with the Dayton gasoline.

The bulk of the data obtained is presented in Table 1 (on the opposite page).

Discussion of Results.

In order to discuss at length the results obtained the data for each series of analytical tests are considered under separate heads, and subheads are employed to differentiate indications obtained in regard to source or method of manufacture of products. In addition some space is given to a consideration of the relations between the properties indicated by the various series of tests.

The scheme of classification employed is shown below:

1. Discussion of individual properties.
    - (a) Specific gravity.
    - (b) Volatility or distillation range.
    - (c) Evaporation losses.
    - (d) Content of unsaturated compounds.
    - (e) Calorific value.
    - (f) Sulphur content.
    - (g) Power developed by engine tests
2. Relations between properties.
    - (a) Volatility and specific gravity.
    - (b) Volatility and evaporation losses.

Specific Gravity.

Specific gravity is the property that is almost invariably measured in the commercial grading of gasolines. Most of the samples obtained have gravities between the limits of 55° and 75° B. (specific gravities of 0.758 to 0.684). One so-called "86°" product showed an actual gravity of 80° B. (0.666). It was not, however, a common market product.

In general the eastern gasolines are lightest, their gravities ranging between 60° and 75° B. (0.737 to 0.683). Products from the Mid-Continent fields fall mostly between the limits of 59° and 68° B. (0.741 to 0.707) and those from California between 57° and 63° B. (0.749 to 0.725). Typical specific gravity values for products from the three fields are listed in Table 2. It is to be noted that there is a tendency in the eastern field to grade gasolines in three classes, in the Mid-Continent field in two classes, and in the West in one class.

Specific gravities of distillation cuts mean little or nothing in themselves and hence are discussed in connection with volatility relations. No conclusions of value may be drawn from a simple knowledge of the specific gravity of a gasoline, except that it seems that only the products from the eastern field are lighter than 70° B. Even this, however, is not a rule, but a mere statement of probability, as there would be no difficulty in making light gasolines from products from either of the other fields, and especially from the Mid-Continent field.

Table 2.

Sample No.	Commercial rating of gasoline (°B.).	Actual gravity as determined by test.		Percentage distilled at temperatures of—					
		Specific gravity.	°B.	Up to 50° C.	50° to 75° C.	75° to 100° C.	100° to 125° C.	125° to 150° C.	150° to 175° C.
EASTERN GASOLINE.									
12	(a)	0.736	60.2	1.2	4.4	20.0	59.0	87.3	99.3
13	68° to 70°	.718	65.0	3.5	15.0	39.2	72.0	91.5	99.5
14	76°	.699	70.3	7.2	33.0	69.7	91.2	....	....
MID-CONTINENT GASOLINE.									
37	58° to 60°	0.745	57.0	1.7	7.4	21.2	50.9	79.4	93.6
38	60° to 62°	.727	62.6	3.3	14.6	41.4	68.2	87.2	96.4
39	68° to 70°	.703	69.2	8.6	34.4	70.4	91.2	....	....
CALIFORNIA GASOLINE.									
49	....	0.749	56.0	3.0	12.6	51.1	81.0	94.8	....
50	....	.733	61.0	3.8	16.1	45.6	71.6	94.1	....

(a) Rated as "motor" gasoline.

Volatility or Distillation Range.

The most important property in determining the utility and commercial value of a gasoline is that of volatility, indicated in the laboratory by the distillation range. Gasoline, like all petroleum products, is a complex mixture of a number of hydrocarbons, these varying in proportion and having different boiling points. Owing to this fact, the possibility of variation in the composition of products commercially classed as gasoline is practically infinite, and all that is possible in defining properties and constituents is to indicate limiting values. Thus, for example, we may say that a high-grade "straight" refinery Pennsylvania gasoline is made up of constituents of which 10 per cent. boil below 50° C. and 85 per cent. between the limits of 50° and 125° C. A blended casing-head gasoline of apparently the same commercial grade might have 30 per cent. boiling below 50° C. and would contain a considerable proportion of constituents having boiling points ranging up to 200° C. Analyses furnishing information of this sort are useful for the study of the property of gasolines, but it should be definitely understood that they are not analyses for individual chemical compounds. Analyses for individual compounds are generally possible only through a relatively large amount of work and are of little practical value. The so-called ultimate analysis, for elements, is, of course, moderately simple, but furnishes information of small value, owing to the similarities regarding the relative proportions of hydrogen and carbon among the hydrocarbons found in petroleum.

Distillation methods necessarily involve mechanical factors which must necessarily be fixed in an empirical way. The results of a distillation are not of significance unless the method of procedure is stated. The general tendency is for apparent boiling points to be higher than actual ones, but this dis-

TABLE 1.—*Results of specific gravity tests, distillations, evaporation-loss tests, and unsaturation tests of 52 samples of gasoline collected throughout the United States in the year 1915.*

[In the table, data referring to gasolines from different refineries are indicated by spacing.]

Sample No.	Trade name.	State from which obtained.	Gravity.		Barometric pressure mm. of mercury.	Results of distillation in 5-inch column of aluminum beads at temperatures of—																								Distillation loss, per cent.	Evaporation loss, per cent.	Unsaturation test.		Total percentage distilled up to—						
			Specific gravity.	°B.		Up to 50° C.			50° to 75° C.			75° to 100° C.			100° to 125° C.			125° to 150° C.			150° to 175° C.			175° to 200° C.			Residue.					Iodine number.	Percentage absorbed in sulphuric acid.	50° C. (122° F.).	75° C. (167° F.).	100° C. (212° F.).	125° C. (257° F.).	150° C. (302° F.).	175° C. (347° F.).	200° C. (392° F.).
						Per cent distilled.	Specific gravity.	°B.	Per cent distilled.	Specific gravity.	°B.	Per cent distilled.	Specific gravity.	°B.	Per cent distilled.	Specific gravity.	°B.	Per cent distilled.	Specific gravity.	°B.	Per cent distilled.	Specific gravity.	°B.	Per cent distilled.	Specific gravity.	°B.	Per cent distilled.	Specific gravity.	°B.											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Motor gasoline	Penn.	0.724	63.4	738	......	......	......	2.2	......	......	31.6	0.709	67.5	41.7	0.727	62.6	18.0	0.742	58.7	......	......	......	......	......	......	5.2	0.784	53.3	0.4	0.8	4.8	......	0.0	2.2	33.8	75.5	84.4	......	......
2	68° to 70° gasoline	...do...	.703	60.2	717	3.5	0.639	89.1	21.1	0.672	78.3	39.9	.699	70.3	23.1	.727	62.6	8.5	.745	57.9	......	......	......	......	......	......	0.0	......	......	0.9	2.0	3.4	......	3.5	27.6	67.5	90.0	90.1	......	......
3	74° to 76° gasoline	...do...	.684	74.7	749	14.5	.633	91.2	31.7	.666	80.2	32.1	.699	70.3	16.8	.727	62.6	......	......	......	......	......	......	......	......	......	4.5	.740	56.9	0.4	4.0	3.3	......	14.5	46.2	78.3	95.1	......	......	......
4	Motor gasoline	...do...	.730	61.8	742	9.8	.624	94.4	4.8	.663	81.2	6.9	.703	69.2	18.2	.733	61.0	28.8	.752	56.2	21.3	0.767	52.5	11.0	0.785	48.3	0.0	......	......	1.2	2.4	7.0	1.0	9.8	14.6	21.5	39.7	66.5	87.8	98.8
5	68° to 72° gasoline	...do...	.712	66.6	742	18.6	.624	94.4	8.5	.666	80.2	9.0	.703	69.2	14.5	.733	61.0	22.1	.752	56.2	15.1	.767	52.5	10.3	.785	48.3	0.0	......	......	1.9	4.4	4.8	......	18.6	27.1	33.1	50.8	72.7	87.8	98.1
6	74° to 76° gasoline	...do...	.690	72.9	742	30.5	.624	94.4	12.2	.666	80.2	12.3	.703	69.2	11.6	.733	61.0	12.8	.752	56.2	10.3	.787	52.5	8.1	.782	49.0	0.0	......	......	2.2	6.4	4.2	......	30.5	42.7	55.0	66.0	79.4	80.7	97.8
7	Auto gasoline	...do...	.730	61.8	748	4.7	.630	92.2	9.3	.669	79.3	18.0	.712	66.6	26.6	.736	60.2	19.7	.758	54.7	11.6	.776	50.4	......	......	......	6.1	.795	46.1	1.0	1.6	11.0	2.6	4.7	14.0	32.0	58.6	78.3	92.9	......
8	68° to 70° gasoline	...do...	.706	68.3	748	9.1	.636	90.1	23.0	.669	79.3	28.4	.709	67.5	22.7	.733	61.0	10.4	.755	55.4	......	......	......	......	......	......	5.2	.776	50.4	1.2	2.8	2.9	......	9.1	32.1	60.5	83.2	93.6	......	......
9	73° to 76° gasoline	...do...	.687	73.8	747	18.9	.633	91.2	28.9	.669	79.3	30.4	.706	68.3	16.2	.730	61.8	......	......	......	......	......	......	......	......	......	4.6	.755	55.4	1.0	4.4	2.4	......	18.9	47.8	78.2	94.4	......	......	......
10	86° gasoline	...do...	686	80.2	741	42.2	.633	91.2	31.4	.669	79.3	15.0	.709	67.5	......	......	......	......	......	......	......	......	......	......	......	......	0.0	.742	58.7	1.5	8.4	2.0	......	42.2	73.6	89.5	......	......	......	......
11	60° to 62° gasoline	...do...	.736	60.2	742	......	......	......	3.2	.669	79.3	13.0	.709	67.5	42.4	.733	61.0	27.6	.749	56.9	12.2	.764	53.3	......	......	......	0.0	......	......	1.0	0.8	5.9	......	0.0	3.2	16.8	59.2	86.8	99.0	......
12	Motor gasoline	...do...	.736	60.2	733	1.2	......	......	3.2	.672	78.3	15.6	.712	66.6	39.0	.736	60.2	28.3	.752	56.2	12.0	.770	51.8	......	......	......	0.0	......	......	0.7	0.8	6.5	......	1.2	4.4	20.0	59.0	87.3	99.3	......
13	68° to 70° gasoline	...do...	.718	65.0	717	3.5	.633	91.2	11.5	.663	79.3	24.2	.706	68.3	33.7	.730	61.8	18.6	.749	56.9	8.0	.767	52.5	......	......	......	0.0	......	......	0.5	1.2	4.1	......	3.5	15.0	39.2	72.9	91.5	99.5	......
14	73° to 76° gasoline	...do...	690	70.3	739	7.2	.636	90.1	25.8	.669	79.3	36.7	.709	67.5	21.6	.733	61.0	......	......	......	......	......	......	......	......	......	7.9	.756	55.4	0.9	2.8	3.4	......	7.2	33.0	60.7	91.7	......	......	......
15	Motor gasoline	...do...	.733	61.0	755	2.9	.630	92.2	8.9	.675	77.4	16.4	.715	65.8	23.4	.733	59.5	21.9	.758	54.7	15.0	.776	50.4	......	......	......	5.9	.801	44.8	0.6	2.0	13.4	1.6	7.0	16.8	33.2	56.6	78.6	93.6	......
16	68° to 70° gasoline	...do...	.706	68.3	738	16.7	.633	91.2	15.4	.672	78.3	20.0	.715	65.8	22.1	.739	53.5	13.1	.761	54.0	......	......	......	......	......	......	10.7	.785	48.3	1.1	3.6	3.2	......	16.7	32.1	53.0	75.1	88.2	......	......
17	73° to 78° gasoline	...do...	.687	73.8	738	30.8	.630	92.2	18.3	.669	79.3	15.3	.712	66.6	13.7	.733	59.5	10.7	.758	54.7	......	......	......	......	......	......	10.0	.785	48.3	1.2	8.0	8.4	2.2	30.8	49.1	64.4	78.1	88.8	......	......
18	Motor gasoline	...do...	.752	56.2	747	0.8	......	......	2.6	.681	75.6	15.4	.724	63.4	33.0	.745	57.9	26.7	.764	53.3	14.1	.779	49.7	......	......	......	6.5	.798	45.4	0.9	0.8	3.0	......	0.8	3.4	15.8	51.8	78.5	92.6	...
19	Gasoline	...do...	724	63.4	747	7.4	.633	91.2	12.6	.675	77.4	28.1	.721	54.2	26.1	.745	57.0	17.1	.764	53.3	......	......	......	......	......	......	7.8	.788	47.7	0.9	2.4	3.7	......	7.4	20.0	48.1	74.2	91.3	......	......
20	62° naphtha	Ind.	.733	61.0	736	5.4	.639	89.1	14.8	.678	76.5	25.4	.715	65.8	21.8	.739	59.5	15.7	.764	53.3	10.8	.779	49.7	......	......	......	4.5	.807	43.5	1.8	1.6	48.8	5.2	5.4	20.0	45.4	67.2	82.0	63.7	......
21	72° naphtha	...do...	.693	72.0	748	17.1	.636	90.1	31.5	.675	77.4	34.8	.721	64.2	13.0	.742	58.7	......	......	......	......	......	......	......	......	......	2.5	......	......	1.1	3.2	8.5	2.0	17.1	48.6	83.4	96.4	......	......	......
22	Gasoline	...do...	.745	57.9	753	4.8	.636	90.1	6.3	.678	76.5	13.5	.715	65.8	21.1	.739	59.5	26.3	.764	53.3	10.4	.779	49.7	......	......	......	7.5	.804	44.1	1.3	1.6	62.7	8.2	4.6	10.9	24.4	45.5	71.8	91.2	......
23	.....do	La.	.752	56.2	751	......	......	......	0.6	......	......	2.7	.715	65.8	23.1	.736	60.2	36.6	.753	56.2	25.2	.787	52.5	9.6	.788	47.7	0.0	......	......	0.2	0.8	10.5	2.0	0.0	0.6	3.3	28.1	65.0	90.2	99.8
24	.....do	...do...	.736	60.2	753	2.6	.642	88.1	7.1	.678	76.5	23.9	.715	65.8	36.0	.742	58.7	20.4	.761	54.0	......	......	......	......	......	......	9.4	.782	49.0	0.6	1.2	44.7	3.1	2.6	9.7	33.6	69.6	90.0	......	......
25	.....do	...do...	.718	65.6	739	4.2	.642	88.1	20.8	.678	76.5	31.1	.715	65.8	27.3	.739	59.5	11.4	.758	54.7	......	......	......	......	......	......	4.6	.779	49.7	0.5	2.0	18.3	2.8	4.2	25.1	56.2	83.5	94.9	......	......
26	58° to 63° gasoline	Okla.	.742	58.7	744	......	......	......	2.3	......	......	23.8	.721	64.2	42.4	.742	58.7	21.8	.761	54.0	......	......	......	......	......	......	8.5	.779	49.7	1.2	0.8	4.1	......	0.0	2.3	26.1	68.5	90.3	......	......
27	60° to 61° gasoline	...do...	.733	61.0	749	1.1	......	......	5.1	.684	74.7	31.2	.715	65.8	37.7	.738	59.5	17.8	.758	54.7	......	......	......	......	......	......	6.1	.779	49.7	1.0	0.8	3.7	......	1.1	8.2	37.4	75.1	92.9	......	......
28	66° to 68° gasoline	...do...	.709	67.5	746	6.9	.636	90.1	24.7	.675	77.4	37.2	.715	65.8	21.1	.738	59.5	7.4	.761	54.0	......	......	......	......	......	......	2.2	......	......	0.5	2.4	1.9	......	6.9	3.6	68.8	89.9	97.3	......	......
29	60° to 61° gasoline	...do...	.733	61.0	746	3.8	.630	92.2	10.7	.678	76.5	22.6	.715	65.8	25.3	.739	59.5	18.4	.758	54.7	11.1	.779	49.7	5.3	.795	46.1	1.8	......	......	1.0	1.2	3.2	......	3.8	14.5	37.1	62.4	80.8	91.6	97.2
30	68° to 69° gasoline	...do...	.703	69.2	747	12.1	.630	92.2	24.3	.675	77.4	33.1	.715	65.8	18.7	.738	59.5	7.5	.758	54.7	......	......	......	......	......	......	3.2	.782	49.0	1.1	2.8	1.7	......	12.1	36.4	69.5	88.2	95.7	......	......
31	Gasoline	...do...	.730	59.5	747	3.0	.633	91.2	8.0	.678	76.5	20.7	.715	65.8	23.1	.739	59.5	20.2	.755	55.4	16.3	.773	51.1	6.6	.788	47.7	2.7	......	......	0.4	1.2	3.5	......	3.0	11.0	31.7	54.8	75.0	90.3	96.9
32	58° to 59° gasoline	...do...	.752	56.2	732	......	......	......	0.7	......	......	13.0	.727	62.6	50.0	.742	58.7	21.1	.761	54.0	11.6	.779	49.7	......	......	......	3.0	.804	44.1	0.6	0.4	2.6	......	0.0	0.7	13.7	63.7	84.8	96.4	......
33	60° to 61° gasoline	...do...	.745	57.9	732	......	......	......	3.0	.684	74.7	29.5	.724	63.4	37.1	.742	58.7	19.5	.761	54.0	8.1	.779	49.7	......	......	......	2.4	.804	44.1	0.4	0.8	2.3	......	0.0	3.0	32.5	69.6	89.1	97.2	......
34	68° to 70° gasoline	...do...	.715	65.8	753	6.2	.645	87.1	26.0	.681	75.6	35.7	.718	65.0	20.7	.742	58.7	8.2	.764	53.3	......	......	......	......	......	......	3.6	.785	48.3	0.6	2.0	1.7	......	5.2	31.2	66.9	87.6	95.8	......	......
35	Gasoline	...do...	.742	58.7	740	2.1	.642	88.1	10.4	.693	72.0	38.6	.736	60.2	32.6	.761	54.0	12.7	.770	49.7	......	......	......	......	......	......	3.2	.804	44.1	0.5	1.6	1.0	......	2.1	12.5	51.0	83.6	90.3	......	......
36	.....do	...do...	.745	57.9	740	1.0	.645	87.1	10.9	.696	71.2	40.4	.736	60.2	30.3	.761	54.0	12.7	.779	43.7	......	......	......	......	......	......	3.0	.804	44.1	0.8	1.2	2.0	......	1.9	12.8	53.2	83.5	96.2	......	......
37	58° to 60° gasoline	Kans.	.745	57.9	750	1.7	......	......	6.7	.681	75.6	13.8	.718	65.0	26.7	.739	59.5	28.5	.761	54.0	14.2	.776	50.4	......	......	......	5.4	.801	44.8	1.0	0.8	4.9	......	1.7	7.4	21.2	50.0	79.4	93.6	......
38	60° to 62° gasoline	...do...	.727	67.6	726	3.3	.636	90.1	11.3	.676	77.4	26.8	.712	66.6	28.8	.736	60.2	19.1	.755	55.4	9.1	.773	51.1	......	......	......	2.5	.798	45.4	1.1	1.2	4.2	......	3.3	14.0	41.1	68.2	87.3	96.4	......
39	68° to 70° gasoline	...do...	.703	69.2	747	8.6	.633	91.2	25.8	.672	78.3	36.0	.712	66.6	20.8	.736	60.2	......	......	......	......	......	......	......	......	......	7.5	.781	54.0	1.3	2.8	2.5	......	8.6	34.4	70.4	91.2	......	......	......
40	58° to 59° gasoline	...do...	.712	58.7	753	1.5	......	......	3.8	.678	76.5	18.5	.718	65.0	33.1	.739	59.5	24.8	.761	54.0	13.0	.776	49.7	......	......	......	5.1	.804	44.1	0.4	0.8	4.4	......	1.5	5.3	23.8	56.0	81.5	94.5	......
41	60° to 61° gasoline	...do...	.736	60.2	758	2.7	......	......	6.6	.676	77.4	22.4	.718	65.0	31.7	.739	59.5	21.0	.761	54.0	10.7	.779	49.7	......	......	......	3.5	.804	44.1	0.5	1.2	4.2	......	2.7	9.3	31.7	63.4	85.3	96.0	......
42	68° to 70° gasoline	...do...	.712	66.6	738	8.6	.633	91.2	19.0	.675	77.4	35.8	.718	65.0	22.9	.739	59.5	9.4	.761	54.0	......	......	......	......	......	......	3.6	.792	46.8	0.8	2.4	2.8	......	8.6	27.6	63.4	86.3	95.7	......	......
43	Auto gasoline	Tex.	.733	61.0	747	2.3	......	......	10.5	.684	74.7	37.2	.721	64.2	28.9	.745	57.9	15.1	.764	53.3	......	......	......	......	......	......	5.6	.785	48.3	0.5	0.8	3.4	......	2.3	12.8	50.0	78.9	94.0	......	......
44	Gasoline	Wyo.	.749	56.0	750	2.6	.646	87.1	8.2	.684	74.7	18.3	.718	65.0	23.0	.749	56.0	22.6	.767	52.6	14.0	.785	48.3	7.7	.801	44.8	2.0	.810	40.0	0.8	1.2	43.8	3.6	2.6	10.7	29.0	57.0	74.6	89.4	97.1
45	.....do	Col.	.745	57.0	737	3.8	.639	89.1	10.8	.687	73.8	29.4	.733	61.0	29.4	.761	54.0	16.6	.770	40.7	......	......	......	......	......	......	0.4	.807	43.6	0.6	1.6	1.6	......	3.8	14.6	44.0	73.4	90.0	......	......
46	.....do	...do...	.745	57.0	737	2.4	.630	89.1	8.9	.684	74.7	23.5	.724	63.4	34.8	.752	56.2	18.0	.776	50.4	11.8	.804	44.1	......	......	......	0.0	......	......	0.6	1.2	1.4	......	2.4	11.3	34.8	69.6	87.6	99.4	......
47	.....do	...do...	.745	57.9	737	1.6	.639	89.1	2.0	.693	72.0	44.6	.739	59.5	33.7	.764	53.3	11.8	.788	47.6	......	......	......	......	......	......	0.0	......	......	0.5	1.2	4.7	......	1.6	8.4	51.0	87.7	99.5	......	......
48	.....do	...do...	.719	56.0	740	3.0	.639	89.1	8.4	.687	73.8	36.6	.739	59.5	38.6	.761	54.0	16.7	.782	40.0	......	......	......	......	......	......	6.0	.810	42.8	0.7	1.6	0.6	......	3.0	11.4	47.0	77.0	93.3	......	......
49	.....do	...do...	.719	56.9	742	3.0	.645	87.1	9.6	.690	72.0	38.5	.736	60.2	30.8	.764	53.3	12.4	.782	49.0	......	......	......	......	......	......	5.2	.813	42.2	0.6	1.2	1.1	......	3.0	12.6	51.1	81.0	91.3	......	......
50	.....do	...do...	.733	61.0	739	3.8	.645	87.1	12.3	.684	74.7	29.4	.733	61.0	26.3	.761	54.0	22.3	.782	49.0	......	......	......	......	......	......	5.5	.810	42.8	0.4	3.2	1.2	......	3.8	16.1	45.5	71.5	91.1	......	......
51	.....do	...do...	.730	61.8	710	8.7	.639	89.1	16.4	.678	76.5	23.7	.727	62.6	25.5	.755	55.4	16.2	.773	51.1	......	......	......	......	......	......	9.7	.798	45.4	0.8	2.4	1.4	......	8.7	24.1	47.8	73.3	89.5	......	......
52	.....do	...do...	.727	62.6	720	14.3	.630	89.1	13.0	.684	74.7	19.7	.733	61.0	24.6	.758	54.7	15.1	.776	50.4	......	......	......	......	......	......	11.6	.807	43.5	0.6	3.2	1.5	......	14.3	28.2	47.0	72.7	87.8	......	......

crepancy is minimized by employing a method of maximum fractionating efficiency. Such is the Hempel method, which was employed in the present work.

Classification of Gasolines.

Gasolines at present on the market may be divided into groups and classes most conveniently by the following classification:

1. "Straight" refinery gasoline:
    (a) From the eastern fields.
    (b) From the Mid-Continent fields.
    (c) From the western field.
2. Cracked gasoline (produced by cracking or synthetic processes).
3. Casing-head gasoline (produced from natural gas):
    (a) Unblended (not marketed).
    (b) Blended with various types of heavy naphtha.

Of the different types mentioned some can be detected by studying their range of volatility. Others must be differentiated by considering relations between the properties of volatility and specific gravity, and still others can be distinguished only by chemical tests.

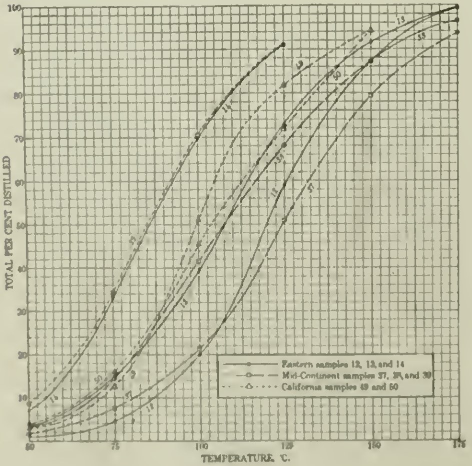
Volatility of Straight Refinery Gasolines.

EASTERN GASOLINE.

A number of different grades of gasoline on the market are produced from eastern crudes by "straight" refinery methods. These are graded according to their gravity, the rating (in Baumé degrees) generally being a little higher than the figure that is obtained in the laboratory. The lower grades are often called "motor" or "auto" gasoline.

Three typical gasolines have been selected from the series and the results of the distillations are represented by the figures for samples 12, 13, and 14, in Table 2, and by the solid curves of figure 1. These three samples were selected because they were fairly representative of the products generally sold on the market and because they were known to be produced by "straight" refinery methods from Pennsylvania crude petroleum.

Figure 1.



There are considerable differences of volatility among the different grades of products, but the boiling points are largely less than 150° C. The heavier gasolines have smaller percentages boiling below 50° C. and larger proportions distilling above 125° C. than the lighter gasolines have.

MID-CONTINENT GASOLINE.

Gasolines from the Mid-Continent fields show similar variations in volatility. Typical samples are represented by Nos. 37, 38 and 39, in Table 2, and by the broken-line curves of figure 1. The differences in the curves are similar to those in the curves representing eastern products and the degrees of difference are much the same, except that there is a tendency to include in the heavier gasolines larger percentages of higher boiling constituents.

Attention must be called to the fact that the products from the Mid-Continent fields are more heterogeneous than the eastern gasolines and that the samples selected (Nos. 37, 38 and 39, from Kansas) are chosen because they seem to be about an average. Some of the other Mid-Continent gasolines are more like the eastern, still others are more like western gasolines.

CALIFORNIA GASOLINE.

In the California market only one grade is put out by the refineries as gasoline, the heavier naphthas being sold under the trade name of "engine distillate." Samples 49 and 50 (See Table 2 and the dotted curves of figure 1) represent two California samples, one from the San Francisco district and the other from Los Angeles. The reader will note that the two samples do not show any striking or characteristic differences and also that the curves fall approximately half way between the limiting curves of the eastern and Mid-Continent series.

Figure 1 shows rather clearly that it is not possible by studying the property of volatility alone to distinguish the gasolines from the three fields. It is, however, important to note the normal ranges of volatility of gasolines produced by straight refinery methods.

Volatility of Cracked Gasoline.

It is impossible to draw any definite conclusions regarding the distillation ranges and volatility limits of cracked gasolines. A number of the samples collected show unquestionable evidence of having been produced by cracking processes, but it is also certain that they are not "straight" cracked products, but rather ones which have been blended with ordinary refinery products. No attempt has been made, therefore, to draw conclusions regarding the volatility of products of this class, except to note that the cracked gasolines on the market do not show any distinguishing features during the process of distillation.

Evaporation Losses.

The results for evaporation losses shown in column 32 of Table 1, and are entirely without significance on an absolute basis, as they show only the relative probabilities of shrinkage. The variations are proportionately great, ranging between 0.8 per cent. and 6 per cent. The average figure for the entire series is 2.13 per cent.

Content of Unsaturated Hydrocarbons.

IODINE NUMBERS.

The content of unsaturated compounds of each sample in the list shown in Table 1. was studied by the convenient and accurate iodine absorption method. The iodine numbers (To be found in Table 1, column 33) represent the percentage by weight of iodine absorbed by unsaturated hydrocarbons and show considerable variations for different gasolines. A relatively large content of unsaturated hydrocarbons indicates that the gasoline under examination is a so-called cracked product, either pure or mixed with gasoline of another variety.

The iodine numbers of the uncracked gasolines varied between 0.6 and 6.5. California gasolines showed the lowest iodine numbers, all uncracked samples from that field ranging between 0.6 and 1.5. The Mid-Continent gasolines ranged mostly between 2.0 and 4.0. The gasolines from the eastern fields showed the highest numbers, several values between the limits of 4 and 5 being discovered, and two gasolines, known to be straight refinery products in the manufacture of which no cracking process was used, iodine numbers of 5.9 and 6.5 were measured.

The iodine numbers of cracked gasolines vary between wide limits, probably on account of the fact that these cracked products are generally put on the market in the form of a blend with some gasoline that is more highly saturated. No attempt was made to determine the low limit of unsaturation which would show a product to be a blend with a cracked gasoline. It seems probable, however, that a gasoline having an iodine number of 8 or higher contains cracked products, and if the number is higher than 10 the indication is practically certain. The heavy naphthas used in producing blended casing-head gasoline are often unsaturated and in the case of several of the samples tested it is reasonable to assume that the producer may not have known that he was turning out a gasoline having a high degree of unsaturation.

The gasoline examined may be divided into three classes—(1) uncracked gasolines, (2) gasolines having small percentages of cracked products, introduced by blending, and (3) ordinary marketable cracked gasolines. In this report these classes have been differentiated as follows: Class 1, gasolines with iodine numbers of 6.5 or less; class 2, those with iodine numbers between 6.5 and 20.0, and class 3, those with iodine numbers between 20 and 60.

The character of gasolines having the iodine numbers of class 1 has been discussed. The gasolines of class 2 were apparently those in which the cracked constituents were in the minority. These products were either of the blended casing-head type or else they came from refineries putting out a moderately small proportion of cracked product. Those of the third class were the normal product of refineries specializing in the cracking process.

Sulphuric Acid Absorption.

All the gasolines of classes 2 and 3 were tested for their content of unsaturated compounds by the sulphuric acid absorption method. The percentages absorbed varied from 1 per cent. for the products of class 2 up to 3 to 6 per cent. for those of class 3.

The sulphuric acid tests were made rather roughly, and it is not assumed that the method is highly accurate. More satisfactory results could perhaps be obtained through the use of different apparatus, as mechanical shaking and centrifugal separation would undoubtedly give results more closely approximating the actual degree of unsaturation. It appears, however, that the sulphuric acid values do not follow in exactly the same order as the iodine numbers. The difference may be due to experimental error, but not necessarily, as the two methods measure different properties. Sulphuric acid absorbs each and every hydrocarbon molecule containing an unsaturated linkage. The absorption is no greater if the molecules contain two or more bonds than if they contain one. The iodine numbers indicate the number of actual unsaturated linkages.

The present work does not permit the drawing of conclusions regarding the value and utility of the cracked products. This problem will probably never be fully settled until gasolines of the cracked variety have been thoroughly tried by a large number of users and under all sorts of working conditions. However, the lack of comment from men in regard to these products seems to indicate that they are giving satisfaction. The experiments reported herein have shown chiefly that cracked gasolines are on the market and that they can be detected even in small proportion by simple and accurate chemical methods.

In this connection it may be noted that at least one other method is in use for detecting unsaturated compounds—namely, measuring under standard conditions the amount of heat resulting from the mixing of gasoline and acid.

Calorific Values.

The calorific values of typical samples, which are given in Table 3, show a difference of only about 1.5 per cent. between the highest and lowest values, and a general, though not universal, tendency for the calorific power (per unit weight) to increase as a gasoline becomes lighter.

The sulphur content of all the gasolines, as shown

Table 3.

Sample No.	Field from which sample was obtained.	Process of manufacture.	Gravity.		Calorific value of gasoline.		Power developed, horse-power-hours per pound of gasoline.	Sulphur content, per cent.
			Specific gravity.	°B.	Calories per gram.	B.t.u. per pound.		
22	Mid-Continent..	Cracking plant .	0.745	57.9	11,165	20,097	1.345	0.02
26	.....do..........	"Straight" refinery.	.742	58.7	11,174	20,113	1.403	.01
43	... .do.........	. .do....... .	.733	61.0	11,180	20,124	1.350	.05
13	Eastern.... ..	...do..........	.718	65.0	11,187	20,137	1.405	.04
19	Mid-Continent..	.....do..........	.724	63.4	11,215	20,187	1.395	.05
38	...do....... .	.....do....... ..	.727	62.6	11,221	20,198	1.396	.03
15	Eastern.........	Blended casing-head.	.733	61.0	11,230	20,214	1.376	.03
1	....do..........	"Straight" refinery.	.724	63.4	11,236	20,225	1.420	.03
34	Mid-Continent..	.....do........	.715	65.8	11,250	20,250	1.365	.02
9	Eastern... . .	....do..........	.687	73.8	11,315	20,367	1.487	.02

in Table 3, is negligibly low, ranging between 0.01 and 0.05 per cent.

Power Developed by Engine Tests.

A number of engine tests of typical gasolines were made with special care and accuracy. The probable error in all the results seems to have been less than 5 per cent. and in most cases about 3. The results of the tests appear in Table 3. The amount of power developed by the different samples did not at the most differ more than 10 per cent. The average difference on either side of the mean was found by calculation to be only 2.1 per cent. From this it seems that the probable error of the experiments, although small on an absolute scale, was so large in relation to the differences that had to be measured that the limited data obtained do not permit the drawing of definite conclusions as to the chemical and physical properties that control these differences. The smallness of the variations is, however, definitely established and leads to the following important conclusion.

All gasolines can, under properly regulated engine conditions, be made to develop about the same amount of power. This result indicates that the claims made by many refiners for the superior power-producing qualities of their gasolines are largely without foundation. It does not necessarily follow that all gasolines are equally good, but it is certain that in some instances exaggerated claims are made for the number of miles obtainable from a gallon. The possible element of superiority undoubtedly lies in some products giving maximum efficiency over a wider range of engine conditions, such products consequently being more nearly "fool-proof" and "weather-proof."

The important fact is, therefore, that if the user of gasoline takes suitable care of his engine he can get almost as good results out of a cheap gasoline as out of an expensive "high-test" product. It is interesting to note that many owners of automobiles have already discovered that a "high-test" gasoline is not necessary and that they are able to get efficient service out of "home-made" blends of gasoline and kerosene. On the other hand, those who use engines not suitably constructed or find it undesirable or inconvenient to make the necessary adjustments may justly claim that high-test gasolines are worth the prices paid.

Relations Between Specific Gravity and Volatility.

As was pointed out in previous pages, certain conclusions may be drawn regarding the source, method of production, and utility of a gasoline from a study of its volatility and specific gravity. It appears that by noting the relations of these properties to each other it is possible to obtain more extensive and more important information than that obtainable by the study of individual sets of properties. One of the most characteristic differences among petroleum products from different fields of this country occurs in the relation between specific gravity and boiling point. Eastern oils are of paraffin base and for a given boiling point have a relatively low specific gravity. California oils are of asphaltic base and show a higher specific gravity for the same boiling point. The Mid-Continent oils are of mixed paraffin and asphaltic base and show specific gravities varying between those characteristic of oils from the other two fields.

In studying the results obtained from the tests of the samples collected it is necessary to be cautious in drawing conclusions as to the source of the crude petroleum used in making a gasoline from the locality in which the sample was purchased. The facilities for transporting crude oil are so highly developed that the location of a refinery means little. Some of the large companies have pipe lines extending through several states, and they are able to distribute their crude oil almost at will. In general, however, it is safe to assume that gasoline purchased in California and in parts of the Mid-Continent area near the producing fields are derived from regional crude oils. In the East, however, this does not hold, as both crude oils and refined products are largely shipped there from fields where prices are lower. A number of the samples tested were, however, obtained from refineries in the Pittsburgh district which use Pennsylvania crude oil. These products were selected as being representative of the class derived from eastern crudes.

Relation of Volatility of Gasoline to Specific Gravity of Original Sample.

Samples from the three fields may show similar distillation curves yet have specific gravities differing by several degrees Baumé. Thus, on inspecting figure 1, which shows distillation curves of a number of typical gasolines from the three fields, the reader will note that three of the gasolines (samples 51, 38, and 13), one from each field, have volatility curves that are approximately the same. The California sample is evidently a little more volatile than either of the other two. The latter are nearly equal, their curves crossing with a slight angle at about the middle point. The specific gravities were as follows: Sample, 51, from California, 0.733 (61.0° B.); sample 38, from Mid-Continent field, 0.727 (62.6° B.); sample 13, from Pennsylvania, 0.718 (65.0° B.).

Another pair of curves (for samples 39 and 12) show a Mid-Continent sample that is clearly a little more volatile than the Pennsylvania product having the adjacent curve. The gravities of these samples were as follows: Sample 39, from Mid-Continent field, 0.703 (69.2° B.); sample 12, from Pennsylvania, 0.699 (70.3° B.).

These comparisons are only qualitative, as the volatility relations could not be put on an equal basis; and in any event the data are insufficient for use in drawing exact conclusions. It is evident, however, that for gasolines of the same volatility the Mid-Continent products are heavier than the eastern and that the California products are heavier than either the Mid-Continent or eastern products.

Relations Among Specific Gravities of Distillation Cuts.

In addition to the valuable information obtainable by comparing the specific gravity of a sample with its volatility range, more or less definite conclusions can be drawn from the specific gravities of the various distillation cuts. Gravities of various cuts for representative samples from the three fields are shown in Table 4. The reader will note that the ranges of gravity of the different cuts overlap so that absolutely definite conclusions can not be drawn. There are, however, as shown by Table 4, differences for average values which fix the probable source of a gasoline. The differences are of about the same general order as those indicated for specific gravities of original samples. For a given volatility an Oklahoma sample is, in terms of gravity, about 2.5° to 3.5° B. (0.010 to 0.014 specific gravity) heavier than an eastern gasoline and a California product is from 4° to 8° B. (0.017 to 0.032) heavier than those of the East. In making this summation, consideration has not been given to cuts up to 50° C., as these have no fixed lower limit.

These differences are greater than those indicated above, and are more reliable and accurate, as they represent a large number of determinations and also fixed conditions of volatility, which could not be attained in the other case where it was necessary to depend upon the relations of single samples to illustrate the points in question.

The blended casing-head gasolines examined resembled the straight refinery products of the eastern field rather closely in volatility and specific gravity relations. The cracked gasolines resembled the Mid-Continent products, possibly on account of their being derived from crude petroleum from that field. Figures for these types of gasoline are included in Table 4.

Conclusions Regarding Volatility-Gravity Relations.

1. It seems that, by studying the volatility and specific-gravity relations of the original gasoline, or, better still, of the distillation cuts, one can determine the source of the product with a moderate degree of certainty. It is also possible, in the case of a

Table 4.

RANGE IN GRAVITY.

Kind of gasoline.	Specific gravity of fraction.						
	Up to 50° C.	50° to 75° C.	75° to 100° C.	100° to 125° C.	125° to 150° C.	150° to 175° C.	175° to 200° C.
Eastern "straight" refinery [a]	0.633 to 0.639	0.666 to 0.672	0.699 to 0.712	0.727 to 0.736	0.742 to 0.755	0.761 to 0.770	....
Mid-Continent "straight" refinery [b]	630 to .645	.672 to .696	712 to .736	.736 to .761	755 to .779	.773 to .779	0.788 to 0.795
California "straight" refinery [c]	.639 to .645	.678 to .693	723 to .739	.752 to .764	.773 to .788	....	....
Blended casing head (eastern) [d]	.624 to .633	.663 to .675	.703 to .715	.733 to .739	.752 to .761	.767 to .776	.782 to .785
Cracked (Mid-Continent) [e]	.636 to .645	.675 to 684	.712 to .721	.736 to .749	.752 to .767	.767 to .785	.788 to .801

Kind of gasoline.	Gravity, in degrees Baumé, of fraction.						
	Up to 50° C.	50° to 75° C.	75° to 100° C.	100° to 125° C.	125° to 150° C.	150° to 175° C.	175° to 200° C.
Eastern "straight" refinery [a]	91.2 to 89.1	80.2 to 78.3	70.3 to 66.6	62.6 to 60.2	58.7 to 55.1	53.2 to 51.8	....
Mid-Continent "straight" refinery [b]	92.2 to 87.1	78.3 to 71.1	66.6 to 60.2	60.2 to 54.0	55.4 to 49.7	51.1 to 49.7	47.7 to 46.1
California "straight" refinery [c]	89.1 to 87.1	76.5 to 72.0	63.6 to 59.4	56.2 to 53.2	51.1 to 47.7	....	....
Blended casing head (eastern) [d]	94.4 to 91.2	81.2 to 77.4	69.1 to 65.8	61.0 to 59.1	56.2 to 51.0	52.5 to 50.4	49.0 to 48.3
Cracked (Mid-Continent) [e]	90.1 to 87.1	77.4 to 74.7	66.6 to 64.1	60.2 to 56.9	56.2 to 52.5	52.5 to 48.3	47.7 to 44.8

AVERAGE GRAVITY.

Kind of gasoline.	Specific gravity of fraction.						
	Up to 50° C.	50° to 75° C.	75° to 100° C.	100° to 125° C.	125° to 150° C.	150° to 175° C.	175° to 200° C.
Eastern "straight" refinery [a]	0.635	0.669	0.706	0.731	0.748	0.767	....
Mid-Continent "straight" refinery [b]	.636	.680	.719	.742	.762	.777	0.791
California "straight" refinery [c]	.640	.686	.733	.759	.780	....	....
Blended casing head (eastern) [d]	.627	.668	.708	.736	.755	.769	.784
Cracked (Mid-Continent) [e]	.640	.678	.716	.741	.761	.778	.796

Kind of gasoline.	Gravity, in degrees Baumé, of fraction.						
	Up to 50° C.	50° to 75° C.	75° to 100° C.	100° to 125° C.	125° to 150° C.	150° to 175° C.	175° to 200° C.
Eastern straight refinery [a]	90.5	79.3	68.3	61.5	57.2	52.5	....
Mid-Continent straight refinery [b]	90.1	75.9	64.7	58.7	53.7	50.2	47.0
California straight refinery [c]	88.7	74.1	61.0	54.4	49.5	....	....
Blended casing head (eastern) [d]	93.3	79.6	67.7	60.2	55.4	52.1	48.6
Cracked (Mid-Continent) [e]	88.7	76.6	65.5	58.9	54.0	49.9	45.9

[a] Samples 1 to 3, 8, 9, 11 to 14. [b] Samples 26 to 42. [c] Samples 45 to 52. [d] Samples 4 to 6, 15 to 17. [e] Samples 20 to 25, 44

product made by blending samples of different volatilities and different types, to ascertain this fact by noting the gravities of the distillation cuts. The lower cuts will show the specific gravity and volatility relation characteristic of gasoline from one producing field—and the higher cuts that of gasoline from some other field. The average gravities for distillation cuts of samples from the three fields are shown in Table 4.

2. For a given volatility a Mid-Continent gasoline is 2.5° to 3.5° B. (0.010 to 0.14 specific gravity) heavier than one derived from Pennsylvania crude, and a California gasoline is 4° to 8° B. (0.017 to 0.032) heavier than the eastern products.

3. The gasolines derived from natural gas (so-called casing-head products) showed specific gravity and volatility relations similar to those of straight refinery products derived from eastern crudes. The heavy naphthas used in blending have, of course, the specific gravity characteristic of the field from which they were derived.

4. The cracked gasolines showed specific gravity and volatility relations characteristic of Mid-Continent products. The gasolines tested were derived from petroleum products from this field. It remains to be proved whether the relations of specific gravity and volatility are fixed by the cracking process or whether they remained unchanged during it.

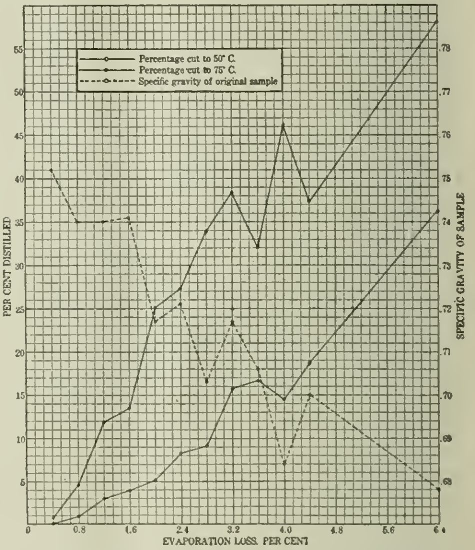
Relations Between Evaporation Losses and Volatility.

The method employed for the measurement of evaporation losses was necessarily such that the results have little value on an absolute basis. That is, it is impossible to predict from the figures obtained what the probable shrinkage will be in the commercial handling of gasoline of the types studied, even if conditions of storage, etc., are rather definitely fixed. The results do, however, show the relative probabilities of shrinkage and differentiate the gasolines in a satisfactory manner. The experimental method employed was necessarily rather crude, but it has been possible to devise a system of averaging results which show sharply defined relations.

Obviously, of course, the percentage of loss by evaporation is regulated by the volatility of the sample, which is in turn a function of its content of low-boiling constituents. The results of the experiments have established this fact in a satisfactory manner. The data obtained have been used to show the average relation between the loss by evaporation and the percentages in the samples boiling up to the limits of 50° and 75° C.

The figures for evaporation losses have been collected carefully. The nature of the figures and their small differences make evident the fact that they involve a proportionately large percentage error. It is also impossible to average these percentages for the purpose of reducing the probable error. On the other hand, however, the averaging of the values with which the percentage evaporation losses are compared seems perfectly feasible and has been adopted, yielding a relation which is fairly clear-cut and definite. Evaporation losses and average figures for specific gravity and distillation cuts up to 50° and up to 75° C. of gasolines, showing the indicated loss are shown graphically in figure 2. The curve showing the relation of the percentage losses to the magnitude of the percentage distilling up to 50° C. is consistent, though a trifle irregular. A similar curve for the total cut to 75° C. is a little less consistent and a little more irregular. A curve showing the relation between percentage evaporation loss and specific gravity of sample shows only a rough relation and is decidedly irregular. This curve clearly indicates that the influence of specific gravity on evaporation loss is accidental and exists only because in a general way light gasolines have large percentages of volatile constituents.

Figure 2.



Summary of Experimental Results.

1. Fifty-two samples of gasoline, of varieties sold throughout the United States during the year 1915, were collected and subjected to a comprehensive series of tests, and in addition about 150 samples were collected in the spring of 1916 and tested for specific gravity only.

2. Of these tests several yielded results that were more or less uniform and negative in value.

(a) The calorific value per unit of weight for the different samples showed a maximum variation of only about 1.5 per cent. between the highest and lowest value obtained. The results are accurate within about 0.2 per cent.

(b) The quantities of power developed under like engine conditions varied only about 10 per cent. between the extremes, the possible error being 3 to 5 per cent.

(c) The sulphur content of the gasolines was so small as to be negligible.

3. The volatility of the different gasolines, as indicated by the distillation range, varied widely. The normal market products have boiling ranges with lower limits varying from below 50° up to 75° C. The upper limits varied from 125° to about 175° C. There were, however, several exceptions to the above general rule. One special "86°" gasoline boiled almost entirely below 100° C. Some of the blended casing-head products contained products boiling up to 200° C. and higher.

No characteristic differences in volatility among products from the three fields were shown, except that in general eastern gasoline showed greater tendencies to vary than the Mid-Continent and the California gasolines. The volatility of the last was more nearly uniform than that of products from the other two fields. Cracked or synthetic gasolines showed no characteristic volatility properties. Blended casing-head gasolines were characterized by an abnormally large content of both low and high boiling constituents and were deficient in constituents boiling at intermediate points of the distillation range.

4. (a) Specific gravities of original samples varied over a wide range, falling between the limits of 75° and 55° B. (0.683 and 0.757 specific gravity), with one exception, the "86°" product, which is not generally sold on the market. Eastern gasolines have the largest range of gravity, varying between 75° and 60° B. (0.683 and 0.737 specific gravity), Mid-Continent products ranged between 68° and 58° B. (0.707 and 0.745) and California gasolines ranged between 63° and 55° B. (0.725 and 0.745).

(b) The specific gravities of the distillation cuts show clearly the differences in chemical nature of the hydrocarbons found in products from the three fields. For a given distillation range Mid-Continent products are in terms of specific gravity 0.010 to 0.014 (about 2.5° to 3.5° B.) heavier than eastern gasolines, and California gasolines are 0.017 to 0.032 (about 4° to 8° B.) heavier than the eastern.

5. The gasolines varied widely in their content of unsaturated compound, a high content of unsaturated hydrocarbons being characteristic of cracked or synthetic gasolines. Uncracked gasolines of the series tested had iodine numbers varying from 1 to 6.5. Products with higher iodine numbers contained greater or less percentages of cracked gasoline. The ordinary product of this type, marketed as gasoline, had iodine numbers ranging between 40 and 60. Products with numbers much lower, but still well above the 6.5 mark, may have been blends containing only small percentages of gasoline made by cracking processes.

For uncracked gasolines the percentages of the various products with numbers much lower, but still well above the 6.5 mark, absorbed by sulphuric acid, were negligible. Cracked gasolines showed losses varying from 1 to 6 per cent.

6. Relative evaporation losses seem to be approximately in direct proportion to the magnitude of the distillation cut up to 50° C.

7. By applying some or all of the tests employed it is possible to settle quite definitely the source, method of production, and probable utility of any sample of gasoline that may be examined.

Suggested Specifications for Purchase and Sale of Gasoline.

In this investigation it was not found possible to include a comprehensive series of experiments showing how the physical and chemical properties of a gasoline control its action in an automobile engine. However, certain indications obtainable from the results given are of value indicating how specifications may be drawn for the purchase and sale of gasoline. The following facts are of interest:

1. The two properties of a gasoline that tend to make its cost relatively high are (*a*) a narrow range of boiling point and (*b*) freedom from unsaturated constituents. These properties are possessed by the so-called "high test" gasolines, which have gravities of 70° to 74° B., and are obtained by "straight" distillation processes.

2. It is evident that the first factor of expense is one that can be efficiently minimized. The results of the engine tests made show that the "high test" gasolines were slightly, if at all, superior to the cheaper products as regards power development, and then only on a weight basis. As gasoline is sold by volume the actual rating runs the other way. The chief element of advantage seems to be that the "high test" gasolines yield maximum efficiency over a larger range of engine conditions. The newer designs in the way of engine construction have largely tended toward making possible the use of gasolines that are more difficult to vaporize. In any event, proper care and adjustment of an engine makes unnecessary the employment of a "high test" gasoline. It appears, therefore, that the user need not purchase the more expensive lighter grades if the engine is efficient in design and if the operator is moderately skillful and careful. Heavy gravity refinery gasolines and cracked gasolines, and blended casing-head products, are now being used in enormous quantities; and as far as can be judged from the absence of complaints regarding them, they are giving satisfactory results.

From the same indications it appears that a high degree of saturation is as unnecessary as narrow boiling range. There are on the market large quantities of cracked gasolines having iodine numbers up to 60, and the content of unsaturated compounds seems to cause the users no inconvenience. It is probable that by suitable adjustment of conditions, especially as regards setting the carburetor to produce a "lean" mixture in the engine, products of even higher degree of unsaturation may be used. The present market products are apparently so refined and blended that their characteristic properties do not even attract attention.

A minor fact that deserves mention is the undesirability of attempting to use "motor" gasoline either as a cleaning fluid or as a drying solvent. This is shown by the high boiling point of some of the constituents in many of the gasolines tested.

To summarize the matter of gasoline specifications, it may be said that the conditions under which the gasoline is to be used should be considered and then requirements should be outlined for as cheap a motor fuel as can be consumed with approximate maximum efficiency. If engine conditions are adjusted to attain this condition, a cheap gasoline will yield as much or even more power than the lighter and more expensive "high-test" products. In addition the results indicate that both cracked and blended casing-head gasolines may be utilized to as great advantage as straight refinery products.

ULTRA VIOLET LIGHT.

Its Application in Chemical Arts.

By Carleton Ellis and A. A. Wells.*

This Is the Second Installment of an Article Dealing with Investigations Conducted by the Writers Into the Possible Applications of Ultra Violet Light, and the Results Obtained Following the Exposure of Various Elements and Compounds to the Action of Its Rays. The Present Installment Continues a Discussion of the Work of Other Investigators. Part III Will Appear in the Next Issue.

PART II.

RUBBER SOLUTIONS AND VULCANIZATION.

Helbronner and *Bernstein* (The Rubber Industry, 1914, 156-63) exposed *rubber solutions,* containing different amounts of sulphur, to ultra violet rays for different time intervals, and the degree of vulcanization (or increase in viscosity) was determined by cementing two pieces of fabric together by means of the solution and determining the degree of resistance to separation. The degree of *vulcanization* (increase in combined sulphur) depends on the concentration of the sulphur in the rubber and on the thickness of the film exposed to the light. Solutions of rubber vulcanized with ultra violet rays are permanent, and if the operation is carried out in the proper manner, will remain constant for a long time. Besides rubberizing cloth the solutions can be used for cements (joining and rubberizing leather and repairing rubber goods). By using these solutions for joining two pieces of rubber a positive absorption of the solution is stated to be obtained and the two pieces of rubber are not separated by a layer of rubber, as is the case where ordinary cements are used.

A thin layer of the rubber solution on an endless band was carried beneath a cylindrical quartz mercury vapor lamp, provided with a cooling jacket, and the vulcanized solution removed by a scraper. The strength of the rubber when used as a cement was determined by measuring the load required to separate two layers of canvas united by means of the vulcanized solution. The strength and viscosity of the rubber solutions before exposure to the rays varied inversely as the percentage of sulphur employed. The amount of combined sulphur in the vulcanized solutions varied very little for concentrations of rubber up to 6%, but fell very rapidly above that point (the added sulphur being kept constant at 5% on the solution). The amount of combined sulphur and the strength of the vulcanized solutions increased with the amount of sulphur used up to 6-7% and then diminished. The thickness of the layer of solution employed was varied according to the color of the rubber and it was found advisable to allow a margin of 40% above the thickness indicated by the spectroscope for complete absorption of the rays. Curves are reproduced showing the depolymerizing effect of the ultra violet rays on a solution of unworked Ceylon rubbers, which showed complete depolymerization (as measured by cementing strength) in seven seconds, and on the other hand the repolymerization of solutions of well worked rubber containing sulphur, the strength in this case, after 54 seconds exposure, almost reaching that of the original unworked, unexposed rubber. The vulcanized solutions were permanent, but tended to undergo further vulcanization after removal from the direct influence of the rays.

Helbronner and Bernstein (Caoutchouc et Guttapercha, 1915, 12, 8720, 8721; J. S. C. I., 1915, 1105) state that rubber in solutions containing sulphur becomes vulcanized on exposure to ultra violet rays, but the vulcanized rubber forms a stable gel and is not precipitated even after several months or by heating to 80°C. for 18 hours; on evaporation the solution yields a film which is insoluble in rubber solvents. Rubber, vulcanized by ultra violet light only, contained 0.6% of combined sulphur, and Helbronner and Bernstein consider that the sulphur acts as a polymerizing agent, and that the combination of rubber with sulphur during vulcanization is merely a secondary reaction. Small quantities of sulphur (0.2%) exert a similar polymerizing action in the synthesis of caoutchouc from isoprene, rendering the product insoluble in benzene.

---

*All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

Bernstein (British Patent 17,195, July 26, 1913) proposes vulcanizing India rubber solutions containing sulphur by exposing them to the action of ultra violet rays produced either by a quartz mercury vapor lamp or otherwise. The solution may be spread on a moving metallic ribbon. A solution of rubber in benzene containing 6% of rubber and sulphur equal to 10% of the rubber when exposed in a film 0.5 mm. thick requires 40-50 seconds for vulcanization. Ordinary or high temperatures, pressure or vacuum, air or netural gas atmosphere, may be used. During his experiments with different kinds of rubber Bernstein (J. Franklin Inst., 1913, 345; J. Chem. Ind., Vol. XII, 193,273) showed that the viscosity is diminished by heating, by mechanical working and by exposure to ultra violet rays, and that if the depolymerization indicated by this reduced viscosity be carried to completion the final result is the same, whatever the agency employed—i. e., solutions of the depolymerized rubber of the same concentration show the same constant viscosity. With Frank and Marckwald's viscosimeter and using a three per cent solution of rubber in xylene the final constant viscosity value is 15 seconds. Depolymerization on heating takes place most rapidly between 60° and 85°C., according to the kind of rubber, and these temperature limits are close to the temperature above which, according to Spence, vulcanization occurs most actively. The vulcanization of rubber can be produced by exposing a xylene solution of rubber and sulphur to ultra violet rays. A xylene solution of a mixture of Hevea plantation rubber with 6% of sulphur was allowed to evaporate so as to leave a thin film on a transparent quartz plate. This was covered by another quartz plate and exposed on both sides for 40 minutes at a distance of 15 cm. to the rays from a Heraeus lamp of 3 amperes and 110 volts. The film then possessed the properties of vulcanized rubber and contained 2.56% of combined sulphur. Other experiments showed that the percentage of combined sulphur increased with the duration of exposure to the rays. The deterioration of vulcanized rubber on exposure to ultra violet rays, observed by Henri, is considered to be chiefly due to "after-vulcanization." The effect of heat or exposure to ultra violet rays on sulphur alone or in solution is to polymerize it, converting it into a colloidal, insoluble form. Bernstein agrees with Axelrod that the vulcanization of rubber involves a depolymerization of the rubber, followed by a polymerization of the mixture. If this polymerization of the mixture be of a physical character it must be accepted that it is due to the adsorption by the depolymerized rubber of the polymerized insoluble sulphur, and this would explain the difficulty of extracting the so-called combined sulphur. It is however, not yet possible to decide finally between the chemical and physical (adsorption) theoris of vulcanization.

Stern (Chem. Zeit., Rep. 1913), in discussing the work of Bernstein, states that depolymerization occurs together with vulcanization.

From Bernstein's observation that normal vulcanization of *caoutchouc* proceeds at ordinary temperatures under the action of ultra violet light, it is concluded by *Ostromyslenski* (J. Russ. Phys. Chem. Soc., 1915, 47, 1892-1898; J. S. C. I., 1916, 370) that, in absence of air, this light activates sulphur by converting it into thiozone; the vulcanization is then effected partly by the latter and partly by the ozones formed simultaneously.

According to *Schopper* (Gummi-Zeit., 1915, 29, 1250; Z. Angew. Chem., 1915, 28, Ref., 644; J. S. C. I., 1916, 356) solutions of *coumarin* derivatives—e. g., 1% solution of dimethylamino-methylcoumarin—may be used to absorb the ultra violet rays and hence protect the fabric of balloons from damage by sunlight.

HALOGEN COMPOUNDS AND HALOGENATION.

The effect of ultra violet rays under varying conditions in the chlorination of *toluol* at 150°C. has been studied with the following results:

(a) Ultra violet light and its visible light gives high yield.
(b) Darkness gives medium yield.
(c) Visible light from ultra violet lamp gives low yield.

Hence, if the determinations are correct or results uninfluenced by any other factor, *visible light retards chlorination, ultra violet light greatly accelerates it* and the latter plus the accompanying sensible light gives a lower chlorination rate than the ultra violet rays alone. Accordingly a screen which stops the passage of sensible or visible light and allows the passage of ultra violet rays would enable the full chlorination rate to be obtained. Glass which has been coated with a thin film of silver stops visible light but not ultra violet light, and its effect should be tested in this connection.

In experiments on the photobromination of *toluene*, made in an atmosphere of 96% oxygen and 4% nitrogen, *Le Blanc* and *Aldrich* (Zeit. Elektro-Chem., 20, 543-7, 1914) found that the yield of benzyl bromide was independent of the intensity of light and was constant throughout the entire portion of the spectrum investigated. The speed of the reaction decreases with decrease of wave length and is practically zero for wave lengths shorter than 300. Experiments on bromine in carbon tetrachloride and in hexane indicate that the increased reactivity of bromine in the light is not due to the splitting off of electrons.

Baskerville and *Riederer* (J. Ind. Eng. Chem., 1913, 5) have investigated the action of ultra violet light on the reaction between natural gas and chlorine and have found that chlorination was not materially accelerated by ultra violet light, but that an acceleration was noted when using the rays of the visible blue spectrum.

Matthews, Bliss and *Elder* (British Patent 16,828, July 22, 1913) have found that in the production of organic compounds halogen hydride is removed from halogen containing compounds with the exception of mono and dihalogen hydrocarbons by treating them in the form of vapor with steam at a suitably high temperature. The mixed vapors may also be treated with the silent electric discharge or subjected to the action of ultra violet light. The removal of halogen hydride may be accompanied by the removal of carbon dioxide, water, ammonia, etc. These subsidiary reactions may be effected or facilitated by means of catalysts or suitable reagents. For example, styrolene is prepared from B-bromo-hydrocinnamic acid.

In a process of the *Badische Company* (German Patent 266,119, Oct. 31, 1911) for the production of *iodine derivatives* of the paraffine series (excepting methane) in vapor form by mixing the hydrocarbons in the dark with the hydriodic acid and subjecting the product to the action of chemical light rays or silent electric discharges the reaction temperature may be reduced by operating under diminished pressure.

Coehn (Berichte, 42, 3183) has found that *hydrochloric acid* is dissociated by the action of ultra violet light. Pure, dry hydrochloric acid gas was placed in a quartz vessel and exposed to light from a quartz lamp, and by such exposure at a relatively low temperature a considerable degree of dissociation occurred. Measurements indicate that this was approximately as great as that obtained when hydrochloric acid is subjected to a temperature of 1500°C. Under the influence of the silent electric discharge dissociation also takes place. Light rays passing through ordinary glass do not affect the equilibrium, but merely the velocity of reaction between chlorine and hydrogen (Abegg and Auerbach, Hdb. d. Anorg. Chem., Vol. IV, part 2, 112).

Marmier (Comptes. rend., 1912, 154, 32) has decomposed solutions of *sodium thiosulphate* containing less than 6 grams per litre by ultra violet light, sulphur and hydrosulphite being formed; the latter is itself rapidly decomposed by the ultra violet light and after 75 minutes exposure no traces remain. The liquid then contains chiefly sulphite. With concentrations above 5 grams per litre no hydrosulphite could be detected.

McLennan (Proc. Roy. Soc. London (A), 91, 23-9, 1914) carried on some experiments using a highly exhausted tube of fused quartz containing a few crystals of *iodine*. This was inserted axially in a Cooper-Hewitt mercury arc lamp with a lateral anode and a short extension at the positive end to which the quartz tube was sealed with wax. The iodine vapor tube was provided with a window of clear quartz toward which the collimator of a quartz spectrograph was directed. Iodine vapor can be stimulated to the emission of a fluorescence spectrum excited by ultra violet light from room temperature to at least 1000°. The wave lengths which can stimulate the fluorescence of iodine vapor lie between 2,100 and a lower limit, probably about 1,800A. Resonance spectra cannot be obtained with iodine vapor when illuminated with light from the mercury arc of wave length shorter than 5,460.74. Portions of the ultra violet fluorescence spectrum of iodine vapor were obtained with methyl iodide and mercury iodide at a temperature of about 326°. Mercury iodide and potassium iodide at a temperature above 326° exhibit fluorescence spectra of their own when excited by light from the mercury arc.

IODIDES.

Strontium iodide in neutral aqueous solutions decomposes, according to Kailan (Chem. Abstracts, 1914, 14) the most rapidly, while *barium iodide* seems to decompose faster than *potassium* and *magnesium iodide,* but when exposed to ultra violet light barium iodide and strontium iodide decompose faster than potassium iodide and sodium iodide, but the barium iodide decomposes faster than the strontium iodide. At 8 cm. from a quartz mercury lamp the decomposition is 200 to 800 times as fast as under the influence of the rays from radium preparations containing 80 to 200 milligrams of radium. The nature of the decomposition caused by penetrating raidum rays and by ultra violet rays is much the same, but the extent of the decomposition is often different. Iodide solutions containing about 1/800 molecule per litre of hydrochloric acid were decomposed more rapidly than in neutral solutions.

ALIPHATIC ACIDS.

Kailan (Monatsh. Chem., 1913, 34, 1209-1244) has found that when dilute (0.5 to 2N-) solutions of *acetic, oxalic, malonic, succinic, malic* and *tartaric acid* are exposed in quartz cells to the action of a quartz mercury lamp, slight decomposition takes place. The speed of decomposition of a dibasic acid was increased by the introduction of an alcoholic hydroxyl group into the molecules. No decomposition took place under similar conditions in glass vessels. The speed of decomposition increases with length of exposure, but does not increase in proportion to increasing concentration of the acid. Any dissolved oxygen only plays a subordinate part, since the acid solution showed at most only a slight reduction in the speed of decomposition when all air had been expelled.

OXIDATION OF SULPHUR DIOXIDE.

Coehn and *Becker* (Z. Physik. Chem., 1910, 70, 88,-115) have studied the formation of *sulphur trioxide* from *sulphur dioxide* and oxygen under the influence of the radiation from a quartz mercury lamp. Experiments made with a quartz reaction vessel mounted within a mercury lamp showed that the formation of sulphur trioxide proceeds fairly rapidly even at the ordinary temperature and more rapidly at higher temperatures. The equilibrium is quite distinct from that attained in daylight. With a mixture of one part sulphur dioxide to one of oxygen equilibrium is attained with a production of 65% of sulphur trioxide. This equilibrium can also be attained starting from sulphur trioxide. At 160°C. with the gases confined in the reaction chamber equilibrium was attained in one hour. In daylight at temperatures below 450°C. the equilibrium condition corresponds to practically 100% of sulphur trioxide. Again the light equilibrium (attained on exposure to the radiation from the mercury lamp) is not displaced by rise of temperature up to 800°C., whereas the dark equilibrium is displaced considerably by rise of temperature above 450°C. With a mixture in the proportions of one part of sulphur dioxide to thirteen parts of oxygen, at 800°C., the yield of sulphur trioxide is 80% on exposure to the rays from the mercury lamp, whereas in daylight, the yield is 44% of sulphur trioxide. The temperature coefficient of the velocity of the photochemical reaction was found to be 1.2. Coehn and Becker consider that a technical photochemical process for the production of sulphuric acid is quite feasible, since on using air in place of oxygen no oxides of nitrogen are formed. Some experiments were made with a special mercury lamp composed essentially of a quartz tube, 115 cm. long and 1.8 cm. diameter. This was inclosed in a tube of opaque English quartz, 100 cm. long and 5 cm. diameter, the annular space between the two serving as reaction chamber. At 450°C., and with the gaseous mixture passing at the rate of 100-150 c. c. per minute, yields of 67.4, 70.8, 92 and 90% respectively of sulphur trioxide were obtained, with 0.78, 0.66, 8.7 and 9.3 molecules of oxygen per molecule of sulphur dioxide.

Sulphuric acid may also be prepared (German Patent 217,772, July 9, 1907) by exposing a mixture of sulphur dioxide and oxygen (or air), preferably containing excess of oxygen, to ultra violet light of low intensity, the gases being heated above 300°C. The yield of sulphur trioxide is increased if the reaction mixture after exposure to the rays be cooled in stages.

MISCELLANEOUS CHEMICAL REACTIONS.

Thiele (Z. Angew. Chem., 1909, 22, 2472) has studied the influence of ultra violet light from a high tension Haraeus mercury lamp on different chemical reactions. The quartz reaction vessel was placed opposite the middle of the lamp only a short distance away and was cooled by a water spray which formed a thin mantle around the vessel. The E. M. F. supplied to the mercury lamp was maintained at about 120 volts. Experiments with mixtures of hydrogen and oxygen were conducted with moist gases, with gases dried by means of sulphuric acid, and with gases dried by contact for eighteen days with phosphorus pentoxide. Combination between the two gases was accelerated by ultra violet light and the presence of moisture was not essential, the reaction velocity being indeed somewhat greater with the dry than with the moist gases. *Carbon monoxide* and *oxygen* also combine when exposed to ultra violet light, but less readily than hydrogen and oxygen. In ultra violet light interaction takes place in a mixture of *hydrochloric acid* and *air,* even when the gases are dried by means of sulphuric acid. *Hydrobromic acid* is also decomposed by air in ultra violet light. The formation of *hydrogen peroxide* from water and oxygen in ultra violet light could be observed only occasionally and appeared to depend largely upon the experimental conditions, possibly upon the presence of impurities. On the other hand, the decomposition of hydrogen peroxide and of *potassium percarbonate* and *ammonium persulphate* was considerably accelerated. *Formic acid, ammonium oxalate, peptone,* and *egg albumen* all suffered more or less decomposition on exposure to ultra violet light. *Potassium nitrate* was reduced to nitrite, with liberation of oxygen; in a N/10 solution, 6.3 per cent of the nitrate was reduced in 2½ hours. A small piece of filter paper lost 0.8 milligrams in weight when exposed for three hours to the ultra violet light. Experiments were also made with water containing about one per cent. of *sulphur* in suspension. In the dark there was no measurable change, after exposure to sunlight for three days, a current of air being passed through the water, a quantity of acid equivalent to 0.5 milligrams of *sulphuric anhydride* was found, after three hours exposure to the ultra violet light (at a distance of about 8mm. from the lamp), quantities of acid equivalent to from 34.6 to 44.8 milligrams of sulphuric anhydride were found.

Condensation of Organic Compounds.

De Wierusz-Kowalski (French Patent 466,918, Dec. 8, 1913) in a process of effecting chemical reactions by means of ultra violet rays, brings about the condensation of organic compounds, such as a mixture of *acetone* and *methyl alcohol* by conducting the mixed vapors under reduced pressure through hollow bodies which are in a high frequency field, in such manner that these vapors themselves act as carriers for the luminescence.

Lesure (J. pharm. chim., 7, 1, 569-75, Chem. Abs. 1911-963) studied the penetration and chemical effects of a Cooper-Hewitt lamp of 3 amperes and 100 volts on solutions of 24 substances. In most of the solutions examined the penetration was as great as with water alone, but only 0.2 to 0.1 as great as in the case of solutions of atoxyl, caffeine, salicylate of eserine, apomorphine, hydrochloride, gentiopicrin and for olive oil, and almost nil for mercury iodide, the bichloride and bisulphate of quinine and for iron methylarsinate. Solutions of *silver nitrate, eserine salicylate, apomorphine hydrochloride, arbutin,* and *guaiacol* were only slightly discolored, but without polarimetric change after an exposure of 15-30 minutes; while solutions of *cocaine hydrochloride, mercury* *benzoate* and *bichloride, sodium cacodylate, calcium glycerophosphate, quinine bichloride* (1%), *pilocarpine hydrochloride* and the artificial *serums* were not affected upon exposure to the light for 30 minutes. Olive oil was bleached in less than half an hour, but not noticeably changed otherwise. To ascertain the possibility of applying this light in sterilizing substances easily decomposed by heat in sealed tubes, cultures of *baccilus coli* were added to 1% solutions of aucubin (permeable) and of gentiopicrin (slightly permeable) and these exposed for 30-1,800 seconds to the light. Sterilization was complete only in the first case.

Baskerville (Electrochem. and Met. Industry Nov. 1906, 435) discussing the use of ultra violet light in the laboratory and in practice, observes that the one very marked property of ultra violet is its power to transform *oxygen* into *ozone*. This takes place best at low temperatures. It has been thought that the ultra violet light from the sun forms ozone in the upper atmosphere which then settles down and oxidizes the impurities nearer the earth. An electroscope is almost instantly discharged under the influence of ultra violet light, but the action is quite slow if a quartz screen is interposed. He notes that an important application of ultra violet light has been in the testing of minerals. Certain minerals are inert, others fluorescent, some phosphoresce, and still others are both fluorescent and phosphorescent. Kunzite was discovered by aid of ultra violet light. A large number of spodumane samples were tested and all found to be inert except one. Upon closer examination this one was found to contain a hitherto unknown mineral which was named *Kunzite* in honor of the discoverer, Dr. Geo. F. Kunz. All the minerals from Mono Lake are phosphorescent after treatment with ultra violet light. Some of the same minerals from other localities are not phosphorescent. The genuineness of *diamonds* may be proven by their phosphorescence after being subjected to ultra violet light. The purity of tailings or precipitates may be tested and minerals sorted. A crushed mineral may readily be separated into a fluorescent and a non-fluorescent portion by sorting while acted upon by ultra violet light. This principle is made use of by the New Jersey Zinc Co. for testing *willemite* concentrates and tailings. The willemite is fluorescent while the gangue is inert. If the tailings contain no fluorescent specks it shows that the concentrating tables are working well. The eye can also roughly judge the degree of concentration in the concentrates.

Wolff (Chem. Zeit., 1912, 36, 197) has examined certain samples of calcined (dehydrated) *potassium carbonate* by means of ultra violet rays which showed in places, a livid red luminescence. With the carefully purified salt this effect was not observed. The effect was traced to the presence of potassium sulphide. Exposure to ultra violet rays affords a simple means of detecting even traces of this substance in commercial potassium carbonate. The salt must be dehydrated and cooled before examination.

Mathews and *Dewey* (Eight Int. Cong. Appl. Chem., 1912, Sect. IX. Orig. Comm. 20,247) have studied the action of ultra violet light on solutions of *sodium sulphite, potassium permanganate, potassium bichromate* and *oxalic acid*. It was found that sodium sulphite solutions are not oxidized by ultra violet light in absence of air, but that the oxidation in presence of air is greatly accelerated by such light. Potassium permanganate and potassium bichromate are very stable towards ultra violet light. Solutions of oxalic acid are decomposed very slowly by ultra violet light, but the reaction is much accelerated by the addition of uranium salts; in this case the decomposition proceeds regularly, the rate varying directly with the amount of uranium salt present.

ACTION ON GLYCERINE.

Henri and *Ranc* (Comptes, rend., 1912, 154, 1261) by subjecting a 10% aqueous solution of *glycerine* for six hours to the action of ultra violet radiation from a 500-volt quartz mercury lamp, have shown that the glycerol molecule is decomposed with the production of formaldehyde and acids as well as other aldehydic substances. The decomposition is considerably increased by the presence of hydrogen peroxide, the activation being proportional to the quantity of peroxide added.

Bierry, Henri and *Ranc* (Comptes, rend., 1911, 152, 535) carried out experiments on the action of ultra violet light on glycerol. Two mercury lamps in parallel served as the source of light. The liquids were placed in quartz flasks or in large open porcelain basins. The experiments were made at different temperatures, in presence of air or in vacuum, and with or without shaking. Lastly the concentration of the glycerol solution was varied from 1 to 100%. After treatment the solutions were concentrated in a vacuum and their behavior studied towards Fehling's solution and phenylhydrazine. The action on neutral glycerol at 25°C. in the presence of air leads to the formation of a glycerose giving a positive phloroglucinol reaction for glyceric aldehyde. The quantity is small and other substances reacting with phenylhydrazine are also formed. In the presence of alkali the product is not glycerose but B-acrose which was identified by means of the phenylosazone. The amount formed is small, but it may be increased by the addition of salts of iron or cobalt or in particular by uranium salts. Numerous other compounds are also formed.

(To be continued in the May issue.)

MARKET DESIRED FOR RAW AND TANNED HIDES.

An American consular officer in Spain has transmitted the name of an exporter of kidskins for the manufacture of gloves, fancy leather for shoes, raw sheepskins and goatskins, and dressed sheepskins for use in fancy goods, who desires to get in touch with American importers of these goods. Correspondence can be in Spanish or English. The name of the exporter can be obtained at the Bureau of Foreign and Domestic Commerce or its district or co-operative offices by referring to file No. 84721.

THE COMMERCIAL DEVELOPMENT OF TECHNICAL BUSINESSES.

George H. Gibson.

By George H. Gibson*

The Translation of Technical Values Into Business Terms in Such a Manner as to Forcibly Register Their Practical Advantages in the Minds of Technically Trained Consumers Is of Extreme Importance, Declares the Writer, and Many Sound Inventions Have Gone Begging Through Lack of Ability to Do This Effectively. In This Discussion of the Subject, the Essential Elements of an Ideal Technical Business Are Set Forth, and the Advantages Accruing From the Right Kind of Publicity Emphasized.

THE application of science proceeds at an accelerated pace. The days have about gone by when one good idea would keep a family in business for several generations. No one dare rest content, for as Solomon remarks, "Yet a little sleep, a little slumber, a little folding of the hands to sleep, so shall thy poverty come." Every manufacturer, and particularly manufacturers of engineering appliances and products, must maintain a constant output of improvements and new developments in order to protect his investment in plant, organization, and good will, and indeed, to stay in business. As has justly been said, the invention of a new machine or process—by some one else—may be as disastrous as a fire, and far more likely to occur.

Moreover, the more progressive, the more advanced, a concern is, the greater will be its volume of new developments and improvements. Inventions breed inventions.

Speedy Marketing Saves Money.

At the same time, the investment of time and money in research and development is a capital risk, that is, the preliminary investigation upon which the design of improved apparatus is based and the provision of manufacturing equipment and organization for turning it out must largely be paid for before the market for it can be developed. It is only by the prompt enlightenment of the prospective consumer, in other words, by educational advertising regarding the applications and advantages of the new article, that the loss of time and the waste which always intervene between the perfection of a device or process and its general use, can be reduced.

The introduction of new things is a speculative venture which bars the timid—but for that very reason it is highly profitable. Patents more or less effectively insure to the originator a safety zone, protecting him from competition for a limited period that he may have the opportunity to recover his great initial outlay. Advertising, however, is equally useful, since it can shorten the period of loss, conserving for profit-making a greater portion of the 17 years' monopoly conferred by the patent and increasing the volume of profit. Advertising itself exerts an accelerating influence on technical development, for before advertising, one should have something worth advertising. Much of the strategy in the competitive selling of engineering appliances consists in originating better methods or designs, or new and improved products.

Foresight Plus Convincing Arguments.

Good business has been defined as the art of selecting probabilities, and it is certainly true that the greatest successes in the engineering businesses have come to men who had the ability to do the following things:

(1) Foresee the need or opportunity,

(2) Develop the solution, and

(3) Focus the attention of the public upon the problem and its solution.

As examples, I might mention Edison with the incandescent lamp, Westinghouse with the air brake and alternating current transmission, Hunt with rope transmission, Sturtevant with fans and blowers, De Laval and Parsons with the steam turbine, Babcock and Neier with the water-tube boiler, Diesel with the oil engine, the Wheelers with surface condensers, Hill with technical journalism, Thurston with technical schools, Patterson with the cash register, Herschel with water meters, Kent with his handbook, and many others.

Early Struggles of Corliss.

The inertia and prejudice which must be overcome in the introduction of a new device may be illustrated by the experience of Corliss with his variable cut-off four-valve steam engine. After he had perfected and demonstrated the remarkable savings of his engine as compared with the engines then common in this country, he was still compelled to give the engines away and take his payment in the fuel saved during the first year's operation, in order to make headway.

---

*Tribune Building, New York City.
From an address delivered before the Technical Publicity Association, March 8, 1917.

Many people have the idea that the invention is the important thing. Very few engineering businesses, however, are founded altogether on exclusive and basic patents. They are based rather on a combination of scientific knowledge and business sagacity, with the help of such protection, monopoly or trading advantage as can be obtained from the detail patents which it may be possible to secure as the development of the art unfolds itself. A man may have the germ of a good idea for a successful business, but still nothing that can be protected by a patent, even though patentable improvements will doubtless be discovered upon developing the idea. Nevertheless, the essential factor is the broad judgment or foresight which leads him to take up certain matters at a particular juncture, and not the specific mechanical contrivances by which he may carry out his ideas. In such cases, the best protection for the idea is advertising by means of which he can promptly get the full benefit of the potential demand for his product before competitors have had time to imitate and develop. Once he has his organization and business well under way, competition will be at a disadvantage.

Organization of a Technical Business.

For businesses up to a certain size, there is nothing that will beat one-man efficiency. The man who can see a need or an opportunity for a need and act accordingly is fit to be the head of a business, if he is also an administrator. However, the organization of modern industrial enterprises branches out into a great multiplicity of specialized details and we cannot always get in one man all those qualities of genius that are necessary in the inventor, in the captain of industry and in the promotion expert. We therefore have performing these functions a number of men who may be described as follows:

First, there is the general strategist, who may have the title of president, general manager, chief engineer, and not infrequently sales manager, since the study of how to sell a product as already built leads almost invariably to the discovery of improvements whereby it can more easily be sold in larger volume and at a greater profit. It is his disposition and function never to be satisfied with things as they are. He is continually studying the trend of engineering, scientific and business developments with a view to visualizing their probable future course. His policy is to build a monopoly of information and brains and then to serve the public with little or no competition by having the best solution for each new problem as it arises.

Nicholson: Chemist and Business Man.

A good example of the necessity of appreciating research on the part of the directors of industrial enterprises is supplied by the editor of London "Engineering," who relates that the firm of Simpson, Maule & Nicholson, in their day leading manufacturing chemists in England, became millionaires largely through the fact that Nicholson was a very able chemist. When he retired, the firm ceased to develop. His successors employed several very able chemists, but these had no control over the business policy and the end was disaster. At one time their leading chemist was the late Prof. Meldola. When he invented his blue, however, the firm refused to take it up, and he accordingly published an account of his discovery, with the result that it founded the fortune of a leading German firm. The successor of Meldola was Prof. Green, who invented primulin, a dye of an entirely new type. This the firm refused to patent, and within a few weeks it was in consequence made in Germany, the whole advantage being lost to England.

Again, some 50 years ago an ingenious engineer invented the duplex steam pump, standardized the type and in time built up an able and aggressive engineering, manufacturing and sales organization. Its success having been demonstrated, this type of pump was taken up by numerous competitors, each of whom developed a complete line, and a comparison of the bulky and closely printed catalogues with page after page of tabulations of sizes and models of duplex pumps issued by the dozen or so builders will indicate the immense amount of money invested in drawings, patterns and manufacturing equipment, not to mention catalogues and advertising. Partly because of pressure of competition, seven or eight of the largest of these concerns went into a merger and eventually into the hands of a receiver. All of their pumps, regarded as assets upon which to base a growing business, have now become practically obsolete, or at least greatly depreciated in value by the perfection of the more compact, simple, reliable and efficient steam-turbine-driven cntrifugal pump as used in all services from boiler feeding to city water works supply.

The Creation of Exclusive Markets.

The steam-turbine-driven centrifugal pump requires precise, scientific design, and accurate manufacturing methods, in order to secure both efficiency and reliability, but if some of the original pump builders had devoted a modest fraction of the time and money spent in copying other reciprocating pump builders to intelligently directed research and commercial development work he might, while continuing to supply the demand for reciprocating pumps then existing, have created a new and exclusive market for himself. It, however, remained for entire outsiders, steam turbine builders, to perfect and introduce the steam-turbine-driven centrifugal pump.

Second, we have, or should have, the inventor or research man. His endeavor specifically is to put the existing business out of business by bringing out something better. He must be an independent thinker, and his department is primarily a thinking and scientific intelligence department, largely free from dictation and direction by minds engaged in the routine of the business. The business man is generally about as good an inventor or research man as the inventor is a business man.'

Researcher-Inventor Must Have Broad Vision.

I have separated the research man from the designer, as it is not so necessary that the researcher-inventor should design as that he should be able to see things from both the maker's and the user's points of view, have a wide play of fancy and the power to co-relate facts. He reads everything. He may even at times take delight in considering the improbable or the unlikely from a spirit of mere novelty and adventure. The man who makes radical inventions is a man of vision, and perhaps of visions; he must penetrate the curtain of convention and habit. One thing is sure, he must not be overburdened with routine, must not travel in a rut and must never entertain the idea that anything has reached finality, or that he has done his utmost. He can quite properly be stimulated to venture freely in the quest for good ideas by some kind of contingent reward, something that will make the work interesting. He should not be discouraged by indefinite, intangible promises or by the offer of a mere fixed salary that may stop at any time.

A few concerns have grasped the value of always pushing forward; it is said, for example, that one automobile builder spends $500,000 per year in research and development. A great number, however, hardly do more than trust for their progress to the inconstant and flickering light of chance ideas.

Functions of the Designer.

The third member of our ideal technical business organization is the designer, the man who works ideas into shape for the shop and the user. While upon his sagacity and skill depend tremendous economies in manufacture, as well as satisfactory performance of the finished article, he is essentially conservative, a stand-patter, having a keen realization of the fact that every scratch of a draftsman's pencil costs money in the pattern shop, foundry and machine shop. The attempt to conduct research in the production department usually demoralizes the latter while rendering the research impotent. It is in this department that production branches from the line of our present discussion, and I shall therefore at once pass to the next member of the organization, the publicity or advertising man.

The advertising manager of a technical business should seek to grasp new ideas in their full import, and in all their implications, and endeavor to estimate and appreciate their possible and probable effects on existing practice and business. He works in close co-operation with the administrative, research and engineering departments, in order that he may understand what they have done and seek to do, and that he may formulate and popularize those ideas which will stimulate and guide customers' demands in conformity with their plans. It is his problem to tell the public how to use it, to make the product more thought of and better thought of, since the value which people will place upon the product naturally depends upon what they know and think about it. He endeavors to bring the user and producer closer together and seeks effective and economical ways for educating the user.

Clear, Forceful Presentation Essential.

His problem is a little different from that of the general advertiser. He must co-ordinate facts of physics, chemistry, engineering and commerce and infuse into them the spirit and purpose of a business. Exacting demands are made upon his breadth of view and industry, but at the same time, his work is facilitated because of the interest which naturally attaches to new things. There is nothing of human use to which interest does not attach, and anything that men have to do with can be made to interest them in some way. Engineers are naturally interested in new forms of construction, new theories and tests and descriptions of installations, and it is the advertising man's part to add pithy, succinct and forcible presentation.

In advertising to managers of enterprises, consulting engineers and others who purchase engineering appliances, he can to advantage appeal to their desire for further knowledge, and to the sentiments, beliefs and ideas of wideawake, self-reliant men, who probably have a large store of systematically organized knowledge which they will bring to bear upon the statements made to them. He must therefore argue logically and with a full command of the facts.

Utility of Products the Deciding Factor.

Engineering products are purchased almost solely for their utilitarian value. Their usefulness can be weighed, measured or computed in some way, they are usually purchased with much deliberation, for the reasoning faculties of the people who buy them have been emphasized by technical and business training.

The advertising should arise from and carry forward the general ideas and beliefs of the guiding mind of the business. It finds inspiration in new products and the exploitation of new fields. As compared with this broad purpose, the means and methods discussed in books on advertising, such as typography and display, color of ink, quality of paper, etc., are to a degree only incidental—all that is asked of them is that they should do their part in transferring ideas efficiently and not get in the way of the main motive, which is the making use of the spectacular qualities of advancement and improvement and the doing or saying of things interestingly.

The world is run largely on ideas and the dissemination of ideas is the business of the advertising engineer.

SOME TECHNOCHEMICAL PROBLEMS OF TODAY

By Dr. Raymond F. Bacon[*]

On May 14, 1915, Dr. Bacon Addressed the Chicago Section of the American Chemical Society on "Some Problems of Chemical Industry," Which Was Later Published, in Condensed Form, in The Journal of Industrial and Engineering Chemistry, Volume 7 (1915), 535. A number of Omissions Occurred in That Brief Report, and He Has Endeavored Herein to Supply, Principally for the Research Workers in Our Universities, the Additions Necessitated for the Completion of the Presentment. The Present Paper is Therefore Supplemental to the Paper Cited.

THEODORE N. VAIL, the distinguished organizer of the greatest telephone system in the world, has well expressed a recent industrial recognition:

> "Research, investigation, experiment, comprehensive and thorough, are now necessary to hold any position in any industrial or utility enterprise."

Mr. Vail attributes the success of his company—the nervous system of our economic and social structure—to the centralized, co-ordinated work of operation with research. Transportation, the circulatory system of the world, owes a similar debt to scientific investigation, for its development has resulted entirely from industrial growth, for which chemical inquiry is so largely responsible. It is now generally conceded that research and progress are synonymous as applied to manufacturing.[†]

The recent impetus imparted to the investigational activity in American chemical manufacturing has materially altered the traditional policy of industrial secrecy.[‡] This change in attitude, the direct product of the appreciation of urgent action in industrial research, has long been desired by our universities, and it will undoubtedly result in the extension of the practice of referring certain of the problems of industry to university laboratories for study. Many of the numerous problems of chemical manufacturing could be advantageously attacked outside of the plants; but some central organization, similar to the Committee on Research in Educational Institutions of the National Research Council, is needed for securing and properly distributing those problems which are pressing. It is clear, however, that stable relations between the universities and industrialists will be worth while only if some mutual benefits can accrue therefrom. This co-operation can therefore be most satisfactorily promoted by actively demonstrating the advantages of the exchange or interchange of subjects for research, which primarily presupposes a reasonable freedom from the concealment of knowledge which tenaciously adheres to all industrial research.

I shall now pass rapidly over a few of the many important problems of manufacture,[**] for the most part in the traditional industries—problems that a few years ago were either not given any consideration or were unknown, but which are now the subjects of considerable contemporary inquiry and even anxiety.

Some Present-day Metallurgical Problems.

A metallurgical problem which invites the investment of research with peculiar force is the concentration of the so-called brown-ore of Virginia, Tennessee, Kentucky, Georgia, Alabama, and Texas. Calcined brown-ore carrying more than 50% of iron is readily marketable and it is said that processes of the type of the Goltra method may be profitably applied not only to these deposits but also to brown-ore "banks" which cannot be worked by old methods of preparation. Other iron-ore problems are the economic utilization of the aluminous ores of Tennessee and of the siliceous potash-bearing ores (gray iron ores) which occur in other southern States.

In blast-furnace practice, there is needed some method of increasing the basicity of the slag without increasing its temperature; very little information is available regarding the amount of sulphur which can be expelled with the top gases; the control of manganese is comparatively incomplete; little is known of the general subject of the effects of variations in the carbon contents of the different kinds of iron, and consequently we are unacquainted in detail with methods for the systematic control of carbon; and there is a lack of exeprimental knowledge relating to the action of a considerable percentage of vanadium in the blast-furnace charge. Reference may also be made here to the problem presented in the production of ferro-vanadium alloys directly from iron ores containing vanadium; this is difficult because vanadium goes into slag very readily.

Other Problems in Siderurgy.

The following are some of the many other problems in siderurgy: the recovery of manganese as an alloy from slags high in manganese; the extension of the commercial uses of open-hearth and converter slags, particulaly a broad study of their use in ceramics; the improvement of the quality of cast-iron or pig iron of ordinary coke grade, to make it the equal of higher-priced charcoal iron; the influence of B-iron on the hardening of steel; the relative merits, as regards corrosion, of various iron products, and especially pure iron as compared with ordinary open-hearth and copper-bearing steels;[*] the cause of internal transverse defects in rails; satisfactory substitutes for imported magnesite as an iron and steel refractory (zirconia is too costly)—this problem actually resolves itself into how to use domestic magnesite—and for graphite as a foundry facing; the cause of the lack of success in the use of ferro-silicon to replace entirely the ferro-manganese in the deoxidation of steel; and the possibility of recovering by-products from blast-furnace gases, such as compounds from which cyanides might be made.

---

[*] From the Journal of the Society of Chemical Industry, Vol. XXXVI (1917), 9.

[†] Bacon, Sci. Am. Suppl., 1915, No. 2081, 334.

[‡] For an illustration, see the reports of the Industrial Conferences at the 53rd Meeting of the American Chemical Society (J. Ind. Eng. Chem., 8 (1916), 947 *et seq.*).

[**] In collating these I have drawn from all available sources of information and especially from my experience at the Mellon Institute.

Mention has been made in several other communications[†] of certain of the problems encountered in the metallurgy of zinc. The treatment of flotation concentrate is one of the present troubles of the zinc smelter, owing to its great fineness. While the proportion of this grade of ore which the smelter is obtaining is still small, the supply of it is, however, certain to increase. The roasting of ferruginous blende in such a manner as to convert all of the zinc into sulphate and oxide, avoiding the formation of sulphite and ferrite, is another interesting subject for research. Two other problems in this field are the manufacture of retorts of higher tensile strength and greater durability, and the relation of the elements of the ash ingredients of the reduction fuel to the same elements in the ore, having in mind a more satisfactory blending of the ore and the reduction material.

Leaching and Flotation.

The increasing adaptation of flotation to the treatment of low-grade copper ores has somewhat discouraged the use of leaching methods and accordingly these processes have not made the progress expected; but the field is still open for oxidized ore where flotation has not thus far been successfully applicable. Successful flotation assumes that the copper content of the ore is in the form of disseminated mineral. In the case of ores in which the copper compound is diffused throughout a mass of gangue, such as is undoubtedly true of the copper silicate ores found at Inspiration, it is certain that flotation is out of the question and that some leaching process must be used.

The acidity of the gases from copper and lead smelting works presents a problem which still awaits solution. In electrical precipitation, the treatment of enormous volumes of gases in the smelter flues introduces several problems: in addition to the magnitude thereof, there are the problems connected with the handling of the fumes and dust and their metallurgical treatment. It is, of course, possible at present to separate from certain fumes thousands of tons of arsenic annually and it would probably be feasible to separate an amount of sulphur which would run into hundreds of thousands of tons annually, were there markets for such quantities of these by-products. The problem therefore resolves itself into the establishment of new tonnage uses for arsenic and sulphur.

Metallurgy of Precious Metals.

In the metallurgy of the precious metals, the high price of zinc has stimulated renewed study of electrolytic methods of precipitation (the new plant at Great Falls, Montana, is illustrative of the trend in this direction) and a large amount of experimental work is in progress on the application of the flotation process. In the case of concentrate produced by flotation, the minerals composing the product are substantially the same as those obtained by gravity concentration, consisting of the sulphides and the double sulphide of the heavy metals, and therefore similar difficulties are encountered in their treatment.

Other more familiar metallurgical problems are the prevention of zinc loss in the brass industry, the elimination of arsenic from antimony, and the cheap deoxidation (retrieving) of aluminium remelted from scrap; but after all the conservation of our metals and their protection after they have been manufactured and put into service holds out most interest.

Utilization of Alkaline-Earth Elements.

Among the less used metals, the alkaline-earth elements are begging utility. There is no doubt that calcium could be produced economically even by methods now known if it were manufactured on a large scale to fill an extensive demand, but markets therefor must first be established by the discovery of important new uses. Results of commercial significance might be obtained by the investigation of the alloys of calcium and of its application as a chemical purifying agent in melting and casting metals. Calcium has been used in Germany as a substitute for ferro-manganese in the deoxidation of steel. In the cases of barium and strontium, uses could be developed if methods were known by which these metals could be isolated cheaply; while with magnesium an electrolytic method is required which will enable its producton for about 25 cents per pound (direct reduction of the oxide, as in the case of alumina, is suggestive). Beryllium is another metal whose properties should receive broad investigation, for at present its known uses do not justify its cost.

---

[*] Because of the immense amount of research which has been carried out on this subject, I have hesitated in citing the above-mentioned problem as unsolved. However, the fact that controversy still prevails places it in that class. Personally, I believe that the use of copper-bearing steels have much the best of the argument.

[†] See Bacon, Science, N. S., 40 (1914), 877; and I. Ind. Eng. Chem., 7 (1915), 535.

Production of Chromium.

The production of boron and ferro-boron of uniform quality requires expert study. Cheap and pure chromium is now unobtainable; the electrolysis of its fused salts is difficult on account of their high melting-points, but perhaps the electrolysis of aqueous solutions of chromium salts could be so controlled that heavy deposits would be produced. Then, too, chromium electro-plating is for many purposes superior to nickel, but the technique of constantly producing perfect plating has not been accomplished.

Since there is no lack of raw materials, broad study should be made of the methods of producing pure titanium and zirconium and of their prospective uses. The same statement also applies to molybdenum, although the greatest need of the molybdenum industry at the present time is a more economic utilization of its sources of raw material: in general, the deposits have been neither properly prospected nor opened up, and then not wisely worked; and loss and waste should be minimized as the result of a careful investigation of crushing and concentrating methods. However, the relatively small tonnage of molybdenum needed at present is a handicap in the exploitation of its ore deposits.

Other Problems of Industrial Inorganic Chemistry.

There is real need of extensive experimental research on the chemical character of coal. The knowledge regarding the combustion and distillation of coal is principally empirical, and will of course remain so until a clearer insight is had of the actual nature of the complex compounds contained in the coal substance and of the mechanism of their decomposition by heat. Two very important problems in the preparation of coal for the market have to do with "wastes": the production of an absolutely smokeless fuel in the manufacture of briquettes from anthracite culm; and the utilization of the high-ash (60—75%), high-sulphur (5—10%) waste from bituminous coal washers.

Many other problems exist in the domain of mineral technology. New uses are desired for tripoli; the Gypsum Industries Association is engaged in furthering the development and advancement of the uses of gypsum; and the employment of slate in the manufacture of blackboards and school "slates" has so decreased that new applications are wanted to replace this loss of market. Then there are the problems in connection with the use of the natural abrasives, emery and corundum; one still hears of the sudden and wide variation in the composition of different shipments; but since the development of high-grade artificial abrasives and the exploitation of larger corundum deposits in Ontario, no corundum has been produced and only a small quantity of emery has been mined in the United States, and accordingly new uses are being sought for these minerals. The abrasive garnet market is also strictly limited and shows little tendency to extension at present. Reference may be made here to several problems in the technology of fuller's earth, the literature of which is meagre and unsatisfactory. Little is known regarding the qualities of fullers' earth which adapt it to its applications; there is a needless obscurity concerning the changes which it occasions in oils and to which it is itself liable; it is not clear why certain earths possess a tendency to cause spontaneous combustion in the material from the filter presses; and, finally, what is the cause of the malodour which sometimes accompanies the use of a particular earth?

The problem of commercially separating a soluble potassium salt from brine containing sodium chloride, carbonate and sulphate and other salines remains unsolved; the cleaning and drying of phosphate rock should be done more economically; and the regenerative system of heating has not been profitably applied to the pottery industry. In fact, an attractive variety of problems is found in all sections of the inorganic field, and many—particularly a compact apparatus for generating hydrogen which could be erected on a freight car and easily conveyed about for Governmental purposes; the economic production of nitric acid from ammonia by the catalytic process; the development of a commercial process for manufacturing aluminium nitride; and the direct preparation of hydrated solium carbonate in a stable, powdered form, and of sodium silicate in a readily powdered, solid, soluble form—might be attacked to advantage outside the purlieus of industry.

Refractories.

However, of all the anxious inquiries coming in from our manufacturers, those pertaining to refractories possibly possess the most notable academic interest. What is the exact inversion point of the crystalline form of calcium oxide? Why is the porous form of calcium oxide so much more reactive than the crystalline? What are the physico-chemical properties of ferrous oxide at high temperatures? What are the relations of the inversion points of the iron oxides to one another? Can alumina be satisfactorily made (sintered) into a dense, hard refractory without the aid of a bond, thus obviating the troublesome shrinkage which occurs at temperatures far below the melting point of alumina? And finally there are the troubles in the case of refractories for open-hearth furnaces. The principal source of difficulty is the slagging tendency of the dust, which is derived partly from the producers and partly from the charges. Perhaps a satisfactory means of suppressing the dust might be devised, but another possible way out of the trouble might consist in replacing the acid bricks of the checkerwork by basic ones. Magnesia and bauxite bricks have been tried, but are liable to shrink; this weakness might be overcome in the case of bauxite bricks by burning at a sufficiently high temperature and by suitably modifying the texture and composition. Dolomite bricks have not been experimented with.

In fact, it sometimes seems to me that the greatest single problem in chemical technology is the one of refractories. There are many industrial problems that now appear to be impossible of commercial solution, which could be immediately solved, provided we had some ideal refractory substance which would retain its shape and strength at high temperatures and would not be acted upon by the acid or alkaline constituents of a charge or by the gases evolved during the reaction.

Problems of Industrial Organic Chemistry.

The inquiries which come from the domain of organic technology are well illustrative of the opportunities which exist for co-operative research, as well as explanatory of the existing anxiety for new ideas in manufacture. More numerous, perhaps, than any others, are queries regarding coal products and their manufacture.

In particular, the problems in connection with the by-product coking of coal are of especial importance at the present time. It is generally conceded that "coke breeze" is not being utilized in the most economical manner; new uses should be found for pitch and coumarone resin; the acid tar from the chemical treatment of light oil should be recovered and worked up; and, for availability in times of peace, there should be accumulated a reserve of knowledge on new uses for benzene and toluene.

The related tar distillation industry represents the following problems:* What is the cause of corrosion in tar stills? Is the present method of separating fractions the best, in view of the products required? Uses are also wanted for creosote oil and for lesser known bodies in the distillates; there is required a broad investigation of coal tar pitch to discover ways of rendering it more suitable for replacing natural asphalts; and the methods for testing coal tar products should be standardized. Two questions which have arisen in the manufacture of coal gas are worthy of mention in this place; these are: Have we exhausted the chemical possibilities of by-product or retort coal gas when we have recovered from it the ammonia it contains; and is it feasible to make gasoline from coal gas? This last problem does not appear to me to be commercially practicable in America, but it is under consideration in England and other countries which produce no petroleum.

The Petroleum Industry.

The numerous problems of the petroleum industry have been considered at length elsewhere,† but references may be made here to several problems of the Scottish shale oil industry. Much remains to be learned regarding the best conditions for the production of crude shale oil, in particular the form of retort and the temperature of working; 80 to 85% of the raw shale put into the retorts is sent to the waste heaps as spent shale, the utilization of which has not been the subject of sufficiently extensive research; and the refinery tars, now used as fuel, could be investigated with the object of separating commercially valuable substances. These problems are of more than mere passing interest to American chemists on account of the probable early development of certain of our oil-shale deposits.

The problems of technical photochemistry are of considerable economic importance. Many of our plants are wasted either because of a lack of knowledge regarding their possibilities or because of a deficiency of interest in their industrial development. The processes for obtaining rubber from guayule sap are unperfected; the method employed for extracting wax from candelilla is crude; algerita and osage orange contain dyestuffs, but have received practically no attention; the commercial possibilties of mesquite seed and wax are unknown, and the same statement applies to the wax or gum from prickly pear cactus; no suitable process is known for degumming ramie fibre and making it suitable for spinning; there is no knowledge of the industrial possibilities of bear grass; the use of rice straw and cotton stalks as paper-making materials requires more study; and the castor bean, sunflower, and camphor tree are well adapted to the coastal plain of Texas and should constitute the bases of well-established industries.

Problems of the Cotton Industry.

The cotton industry holds out engaging opportunities for chemical research. The following are some of the problems which confront the planter of cotton: What is the action of various fertilizers on the yield of cotton and on the quality of the fibre produced? Are there available any fertilizers which can be substituted for potash, and, if so, what conditions must be observed in their application to the soil. Can a chemical treatment be devised for destroying the Mexican boll weevil, or at least rendering it more harmless? And then there are some problems in preventing the production of stained cotton during seasons of excessive rain, and in bleaching a stained cotton a pure white.

The chemist has been of inestimable value to the wood turpentine industry. In addition to developing processes and designing suitable plants, he has standardized the products, created markets therefor, and found uses for the important by-product, pine oil. However, there are still opportunities for other chemical contributions. Fresh crude turpentine contains normally about 30% of spirits of turpentine, but under the most improved methods of collection and distillation in use at present, yields of only 18 to 20% are obtained; this loss of at least one-third of the volatile oils remains to be overcome. The French method of bleaching rosin is slow and otherwise uneconomic, but the chemical methods which have been proposed are unsatisfactory; methods of distillation by the use of superheated steam or vacuum, although apparently desirable, have so far had no altering influence on methods of manufacture; and the disadvantages of wood fibre from turpentine production as a source of pulp remain to be overcome. Notwithstanding its charcoal and bark contents, this fibre is said to produce a satisfactory grade of brown wrapping paper, and there is now some activity in this utilization. The question of substitutes for wood in the manufacture of paper pulp is a pressing one, and any source of relief is gratifying. Perhaps the manufacture of tannic acid extract from palmetto roots and other sources might be made profitable by the production of paper pulp from the fibre residue.

---

*On other problems of the coal-tar industry, see Bacon, J. Ind. Eng. Chem. 7 (1915), 535.

†Bacon and Hamor's "American Petroleum Industry," 1916, 2, 798-807.

Other problems in the organic branch of chemical industry are the production of a satisfactory butter-substitute from soya-bean oil, the cheap extraction of vitamines from rice hulls and from yeast, the recovery of the wax occurring on the outer surface of the sugar cane, and the economic production of ammonia from sources in the various stages of beet sugar manufacture.

Some Needed Commercial Syntheses.

The many opportunities that lie everywhere at hand in this entire field, and particularly in pharmaceutical chemistry, make one frankly consider why expert organic chemists should devote laborious days to preparing some substance of purely academic interest, while there is urgent need for practical working processes for the synthesis of atropine, cocaine, morphine and quinine. One is reminded of Chesterfield's remark that:—

> "Very few people are good economists of their fortune, and still fewer of their time."

when this mismanagement of laboratory resources is further evidenced by citation of the following instances of desired commercial syntheses: formaldehyde, acetic acid, amyl alcohol, tartaric and citric acids, sanguinarine, hydrastine, caffeine, and nicotine.

A favorable occasion for industrial service also exists for the physical chemists of our universities. To mention one illustration from the field of organic chemistry, but little progress has been made in the employment of light in the manufacture of such chemicals as the chlorides of carbon, although photochemistry has developed into an important theoretical branch. Light is a powerful, uncontaminating catalyst for effecting certain chemical reactions, and the white flame arc has opened up many possibilties for controlling and altering oxidation and halogenation processes.

The problems listed above represent only a fraction of those which might be disclosed, but they are illustrative of the opportunities for applying scientific knowledge and investigational methods to the domain of industry. On every side, the research men of our universities are needed for the execution of real attainments in the technical world, with its difficulties, and unexplored lines of manufacturing.

CONVERSION OF BARIUM AND RADIUM TO CARBONATES

Methods for Carrying on This Reaction at Low Temperature Reported by U. S. Bureau of Mines Experiment Station.

The Golden, Colorado, Experiment Station of the Bureau of Mines, Department of the Interior, reports that it has been found that, by fusing radium barium sulphates carrying a considerable proportion of silica with a mixture of caustic soda and sodium carbonate, the whole of the barium and radium are converted into carbonates. The amount of sodium carbonate required is comparatively small, 10% to 15% only being required. The reaction goes at a low temperature, and the difficulties of fusing with carbonate alone are entirely eliminated. The product is also much more easily washed free from sodium silicate.

The equipment and installation of the technologic laboratory at Golden have been almost completed. The laboratory is designed to handle rare metal ores in quantities from 10 lbs. to 500 lbs. It is designed to make any kind of an acid leach; any kind of an alkaline or salt leach; and any kind of a fusion. In addition a small Wedge type roasting furnace has been installed as well as a tube furnace which can be used either for oxidation purposes or for reduction.

SHORTAGE OF AMMONIUM SULPHATE FOR JAPANESE

From Consul-General George H. Scidmore, Yokohama, Japan, comes a report to the U. S. Bureau of Foreign and Domestic Commerce regarding the shortage of ammonium sulphate in that country owing to the cessation of imports from England. A portion of his letter is printed in the daily report of the bureau, as follows:

"Supplies of sulphate of ammonia in this country states the Japan Chronicle, are becoming increasingly short. Japan gets its imports principally from Great Britain, but shipments thence have greatly decreased. During December, 1916, Great Britain exported 23,029 tons, bringing the total exports for last year to 259,300 tons, a decrease of 35,000 tons from the quantity for the preceding year. Of last year's total exports from Great Britain, shipments to Japan amounted to 9,155 tons, a decrease of 1,382 tons compared with the preceding year. Lately shipments to this country have practically stopped, and a cablegram received in Osaka says that no shipments will be possible for the present.

"Sulphate of ammonia is produced in this country but the output is insignificant—not more than 3,000 tons a year—while last year's consumption in the Kobé and Osaka districts alone amounted to about 7,000 tons."

A NEW FLOTATION OIL

And a New Source of Flotative Agents.

By Oliver C. Ralston.*

In His Discussion of the Papers of Maxwell Adams and G. H. Clevenger, presented at the Arizona Meeting, American Institute of Mining Engineers, the Writer Gives Numerous Interesting Cost Data in the Hope That Further Experiments May Be Undertaken to Determine the Economic Merits of Sagebrush Oil as a Flotative Agent.

WE are indebted to these two gentlemen for the work which they have done with the oils derived from sage brush. Their work should not be confused, however, as the work of Mr. Adams deals with steam-distilled oils and that of Mr. Clevenger with destructively distilled oil, largely. In other words, Mr. Adams' oil is probably the original essential oil that existed in the brush before distillation while Mr. Clevenger's oil not only contained this essential oil but also some products of destructive distillation of the wood constituents.

I had noticed the work of Mr. Adams on attempting to separate the various constituents in the oils of some of the Western conifers and had sent to him to ask if he could send me small samples of some of these pure products. This he very kindly did, and with them included some samples of oil from the common sage brush, whose characteristics he has here described, as well as a sample of oil from the common "rabbit brush." Only the sage brush oil proved of much value for flotation, but it was very powerful, and I so informed Mr. Adams. Even in amounts as small or smaller than one-tenth pound per ton of ore, it gave very quick and positive flotation of many ores, with high-grade concentrates and good extractions. It proved to be especially desirable for the flotation of carbonates of lead and of copper which had received an artificial coating of sulphide by treatment with a solution of a soluble sulphide.

I also received a sample of crude pyroligneous acid from sage brush prepared by Dr. W. C. Ebaugh, of Salt Lake City. It did not do very good work in flotation, but it is possible that by concentration of this product to obtain the residual tar a good flotation oil might result. This has not been done as yet and I am sorry to see that Mr. Clevenger has not done this. It might be that the dissolved tar, added to the settled tar, would make a total yield of flotation oil higher than the 4 per cent. which Mr. Clevenger feels is a safe estimate. The importance of this point will be seen in the following discussion of the possible costs of sage brush oils for flotation.

I have been fortunate in obtaining the approximate costs of collecting sage brush, as well as the costs of operation in the ordinary wood-distillation plants. I was given the former by E. H. Snyder, who with a number of associates cleared some land of sage brush and made potash from the ashes of the burned brush. The latter were given me by R. C. Palmer, formerly of the Forest Products Laboratory of the Department of Agriculture.

The clearing of land of its sage brush is ordinarily accomplished by means of a tractor pulling a special frame made up of railroad rails. This breaks off the brushes so that they can be collected in hay ricks and hauled to a central point. For merely uprooting the plants and burning them on the spot the cost is about $4 per acre, but to recover them and take them to a central point ready for burning or distillation, costs about $6 per acre.

Mr. Snyder further informs me that with the average 4-ft. stand of brush in southeastern Nevada the yield per acre is about 7 tons of brush. I am informed that there are considerable stretches of country around Bear Lake in Idaho and Utah where the brush is nearly 10 ft. high. Hence considerably higher yields might be possible. However, we can take as a safe figure $1 per ton for cutting and collecting the brush to a central point.

The cost of destructive distillation of hard wood is in the neighborhood of $8 per cord (4,000 lb.) of wood, or about $4 per ton—possibly $5 per ton of wood. While the sage brush might be more bulky than the wood, and hence cause higher costs, this factor can not be estimated at the present time and it is probably best to count on a distillation cost of $5 per ton.

That would make the total cost of treatment of each ton of sage brush about $6, and the yield, according to Clevenger, is 4 per cent. or 80 lb. of tar. This would mean about 10 gal. produced at a cost of $6, or $0.60 per gallon, or 7.5 c. per pound. This is rather high but is comparable with the present price of pine oil, of which sage brush oil seems to be the full equivalent, if not the superior. With most ores, less than 0.5 lb. of sage brush oil should be needed per ton of ore.

If Clevenger's figure of 4 per cent. yield of oil could be raised to 6 per cent. by addition of the dissolved tar from the pyroligneous acid, the cost of the oil would be about 43 c. per gallon. Further, if greater yields of brush from each acre were obtainable, the costs would be cut slightly, although this point is not of so much importance, as the principal costs are due to the distillation. It is also possible that in some cases owners of the land would be glad to pay $1 to $2 to have their land cleared of brush, where it would usually cost them about $4. Only skilful management and the choice of the proper regions for operations would probably bring in this latter source of income.

---

*From the November Bulletin of the American Institute of Mining Engineers. Discussion of papers of Maxwell Adams and G. H. Clevenger presented at the Arizona Meeting, September, 1916, and printed in Bulletin No. 117, September, 1916, pp. 1683 to 1684 and 1685 to 1692.

There is one other source of income from the products of the sage plants, namely, the potash. Mr. Snyder informs me that he found the potash in carefully burned brush ashes to amount to 15 to 20 per cent. of the total weight. Most of this was soluble in water but the remainder was "acid soluble K_2O." The ash amounts to 7 to 10 per cent. of the weight of the plants. Hence the K_2O content of the brush can be estimated as from 1 to 2 per cent., or 20 to 40 lb. per ton of brush. In normal times potash is worth about 3 c. per pound. This would make the value of the potash in the brush about $0.60 to $1.20 for every ton. The cost of leaching and crystallizing the potash from the aches is unknown, but might possibly be $3 on every ton of ash or 20 to 30 c. referred to every ton of brush. It is not impossible that the burning of the sage brush charcoal under the boilers of the distillation plant, followed by leaching of the ashes would yield potash of sufficient value to allow a profit, and hence allow of production of sage brush oils for flotation at a lower net cost than the above rather pessimistic figure. One difficulty at the potash end of the work is that it tends to be carried away in the combustion gases and a Cottrell precipitator might have to be used in order to insure recovery of all the potash.

The above is merely a suggestion to show what might be expected if one were to attempt the commercial production of sage brush oil. Rather high costs were assumed, but it is certain that other sources of expense than those enumerated will make such a pessimistic figure desirable, for the sake of safety.

About 10,000 gal. of steam-distilled pine oil are being used every month in the United States for flotation purposes and more would be used if the price were lower. The last quotation that I heard for pine oil was 67 c. per gallon, f.o.b. New York. If sage brush oil could be produced for 40 c. per gallon it is probable that the market would jump to at least 25,000 gal., or roughly 1,000 gal. per day. With this would be produced 3,000 to 4,000 lb. of potash, an amount which is much less than 1 per cent. of the total consumption in the United States. Hence the sale of potash from such a source should have no bad effect on the market. On the other hand, if the oil could be produced for 25 c. per gallon, there is no reason why its use should not amount to 10 times the consumption of the oil at a 40-c. rate.

It is to be hoped that these figures are attractive enough to cause experimentation on a reasonably large scale, to determine whether operations can be profitable. Only by such a method can it be estimated whether we have a new source of flotative agents and a new source of potash.

BARRETT COMPANY INCREASES CAPITAL.

Announcement has been made by the Barrett Company of an increase in its capital stock from $20,000,000 to $37,500,000.

JAPANESE AND AMERICAN OILS IN SOUTHERN CHINA

Aided by High Freight Rates, Japanese Producers Enter Hongkong Trade Field In Competition With Americans.

Under date of February 9, Consul General George E. Anderson writes from Hongkong to the United States Bureau of Foreign and Domestic Commerce as follows:

"The high freight rates which have obtained during the past two years on all cargo from the United States to the Far East have caused a big boom in the production of petroleum in Japanese territory and a great increase in the sale of Japanese oil in the Hongkong trade field in competition with American and East Indian oil. Immediately previous to the war Japanese oil had secured a foothold in this field, particularly in the Foochow, Swatow, and Amoy districts. Imports of Japanese oil into all China increased from a value of $108,550 in 1913 to $161,615 in 1914 and $945,855 in 1915. Much of this increase was in the districts mentioned, and it was largely at the expense of American oil trade, the Japanese product representing about a quarter of the whole in those districts in 1915.

"During the past year there has been a great development of the trade because of the constant rise in freights from the United States. Previous to the war, oil enjoyed exceptional treatment. It was used largely as reserve cargo, and was carried at the lowest freight rates, usually rates much below the market. Since the contraction in tonnage due to the war, however, kerosene has paid rates in proportion to other cargo, rates on oil during 1916 from the United States, in fact, being substantially five times what they were previous to the war. Naturally Japanese oil, with the short haul from Japan in subsidized vessels carrying the oil at rates fixed by the Japanese Government, has had an immense advantage. The price of oil in Japan has increased immensely during the past year, but most of the time the price of such oil for export has not increased in proportion. The home market in Japan is reported as booming as a result of the decreased import of foreign oil due to increased prices and higher freights. All these conditions are resulting in the development of strong oil interest in Japan and Formosa which promise serious competition for American oil in the future.

"Because of the scarcity of tonnage and high freight rates, also because of disturbed conditions in South China, the consumption of petroleum and its products decreased about 40 per cent during the year. Nevertheless prices remained about the same as they were at the beginning of the year. Stocks have been greatly reduced and will remain low until freight rates are reduced."

COMPARATIVE TESTS WITH MANGROVE AND WATTLE BARKS

By

F. A. Coombs, F. Alcock and A. Stelling*

In Making the Tests Herein Recorded, the Writers Used Principally the Rhizophora Mangrove. It Was, However, Impracticable to Keep the Different Kinds Separate, and Experiments Were Made with the Ordinary Commercial Mixed Bark. Tests Were Made Alternately to Guard Against Any Possible Variation in the Right and Left Halves of the Hide. No Experiments Were Made on Soaking at 45° C.

THE mangrove barks are now being used in large quantities by tanners who are producing sole-leather. These barks have a very high tannin value and very large supplies are available for the production of leather.

In a previous paper** we gave the tannin values of some Australian mangrove barks. After examining the mangrove trees in Cairns and Cooktown districts, North Queensland, we found that *Rhizophora mucronata* represents fully 75% of the trees suitable for stripping, the remainder consisting largely of *Brugiera gymnorrhiza* and *Ceriops condolleana.* For commercial reasons strippers are not likely to take the bark from the different species and keep each one in a special grade. The above three species† grow in a very mixed state and buyers can assume that bark from these districts consists of an excess of *R. mucronata* and small varying proportions *B. gymnorrhiza* and *C. condolleana.* The majority of the mangrove bark from German East Africa‡ is also taken from the above three species.

We have used the commercial mangrove bark for our tanning experiments, and *B. gymnorrhiza, R. mucronata*, and *C. condolleana* were examined by the aid of the usual qualitative tests.

Values for Mangrove.

The color and precipitation tests gave results which did not differ from those described by other workers for the mangrove bark. The solubility tests for mangrove tannins have not received a great deal of attention from leather chemists, and the results given for these tannings may have been obtained from one or a mixture of the genera which are described as mangroves.

The following values have been given§ for mangrove: Ethyl acetate figure, 0 to 5; alcohol figure, 0 to 5, and gallic acid value, 0.68.

These differ to a certain extent when compared with our results shown below.

TABLE I.

	C. condolleana.	*R. mucronata.*	*B. gymnorrhiza.*
Ethyl acetate figure	20 to 25	7	4
Alcohol figure	0	0	11, 12, 24
Gallic acid value	0·785, 0·738, 0·692, 0·657	0·600, 0·595, 0·501, 0·479	0·450, 0·385, 0·381, 0·359

Proctor and his students have carried out a considerable amount of work in connection with the oxidation of tannins with permanganate and the results obtained are useful as qualitative tests for the recognition of various tannins. He gives the gallic acid value of one grm. of chestnut tannin as varying between 0.56 and 0.66 and of valonia tannin as varying between 0.55 and 0.63.

Variations Common to Mangrove.

These variations are common to mangrove and apparently no constant figure can be given which represents the gallic acid value of these tannins. The gallic acid value of mangrove tannins apparently reaches the maximum with *C. condolleana* and the minimum with *B. gymnorrhiza.* Proctor states that the phlobaphenes or reds are probably anhydrides of their respective tannic acids, and it is a well-known fact that the catechol tannins change on exposure to heat or light from a medium to a dark red color. This change brings about a more complicated and larger molecular aggregate; and as this aggregate increases its solubility in water decreases, until it finally reaches the state known as insoluble reds of phlobaphenes. The tannins in wattle and mangrove barks appear to exist as variable molecular aggregates ranging from the parent body, or unit molecule, to the insoluble red; and it is probable that the oxidation values would differ for the unit molecule and the difficultly soluble reds. The tannin from *B. gymnorrhiza* has a low oxidation figure and probably a high molecular aggregate. Mallet bark tannins also have a low oxidation value (gallic acid value, 0.288) and the rate of penetration is slow.

Recently Bennett (J. Soc. Ind. Chem., 1914, 1182) suggested certain changes in the I. A. L. T. C. official method for estimating tannins. He believes that the present method returns a high percentage of non-tans, and we are confronted with the problem that certain substances exist which are tannins or non-tannins according to the ratio, within certain limits, between hide-power and tannin.

---

*From the Journal of the Society of Chemical Industry, Vol. XXXVI, No. 4.

**Australian Mangrove Barks, Leather World.

†Specimens identified by Dr. J. Shirley, Brisbane.

‡See Paessler. Collegium, 1912; this J., 1912, 446.

§Leather Chemists' Book, Leeds University.

Oxidation Figures Wanted.

The non-tannins have a low oxidation figure and it would probably throw some light on the subject if oxidation figures were obtained for tannins and non-tannins from one sample of bark, using both the official and Bennett's revised methods for estimating the tannin. Such results would show if the substances under dispute were akin to tannin or non-tannin, and we might get a better view of the value of the gallic acid figure.

The leather-forming properties of mangrove barks were tested by an experimental process described in *Collegium.**

Two duplicate tests were carried out for comparative purposes, and wattle bark was used for the standard tannage. The mangrove bark has already been described and the wattle bark was the same as the tanners use under the name of Adelaide bark (*Acacia pycnantha*).

Division of the Hide.

The hide is cut into sections of equal area and numbered as shown in the diagram. The sections are approximately 1 ft. 9 in. square and they are soaked, limed, and tanned in upright vats measuring 2 ft. x 2 ft. x 4 in. Two sections are suspended in each vat and about 32 litres of liquor is required to cover them.

The sections 1 and 5, 2 and 6, 3 and 7, and 4 and 8 are approximately constant in area, thickness (substance) from grain to flesh, and in general structure.

The first two sections, Nos. 1 and 5, are both soaked, limed, and delimed in the same vat at the same time; therefore temperature, time, and constituents of all liquors are constant for these two pieces until they reach the tan liquors. Then they are separated and No. 1 goes into wattle-bark liquors and No. 5 in mangrove liquors. Under skilled control these two sections are approximately constant until they reach the tan liquors, and then if any variation occurs it will be due to a difference either in the process of tanning or in the tanning materials. In this experimental work the tanning process has been kept approximately constant for both duplicate tests, so that if the hide sections be constant the variations can be traced to difference in the tan liquors (acidity, non-tans, etc.) or in the structure of the tannin molecule. What has been said of Nos. 1 and 5 applies also to the groups Nos. 2 and 6, 3 and 7, and 4 and 8, but it is hardly necessary to point out to practical men that No. 1 will differ from all others with the single exception of No. 5 section, and likewise No. 4 will differ from all except No. 8 section.

Results of Two Tests.

Sections 1 and 5 and 2 and 6 were used for the first test and the other two pairs were used for the second. For both the soaking occupied two days with two changes of water; liming seven days in one fresh lime liquor; wash pits (after dehairing, etc.) two days, with two changes of water; and deliming one hour in lactic acid solution (2 grms. per litre).

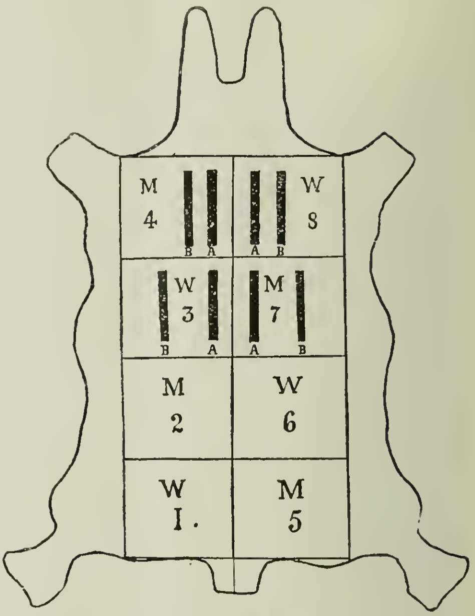


Diagram of Ox-Hide.

The tanning process was continued at a constant tannin strength for both tests.

Acidity of the mangrove liquors for both tests is higher than the wattle liquors, and one might therefore expect the mangrove leather to fix more tannin. However, we are now carrying out comparative tests for the value of acid in tan liquors and hope to discuss this point at a future date. The variable ratio between tannin and specific gravity is fully demonstrated in both tannages. The wattle tannins penetrated the hide quicker than the mangrove tannins.

Figures Show a Small Irregularity.

The figures for the tanning process show a small irregularity due to the process of extracting the tannin from the bark. We are extracting tannin from the bark at irregular intervals and some liquors had a short time for exposure to fermentation. The amount of difficultly soluble tannins was low for these tan liquors, and these conditions might adversely affect the percentage of combined tannins.

The following are results obtained by weighing each section after it was taken out of the various tan liquors. The pelt weight is taken at 100 and the percentage in-

---

*October 12th, 1916; J. of Soc. of Chem. Ind., 1916, 1028.

First test.

	Sections 2 and 5. Mangrove bark liquors.			Sections 1 and 6. Wattle bark liquors.	
Days.	Tannin.	Barko-meter.	Lime water.	Barko-meter.	Lime water.
	grms. per litre.		c.c.		c.c.
2	16·64	8·2°	2·6	7·7°	1·8
4	24·96	12·3°	3·9	11·6°	2·7
6	35·56	18·0°	4·7	17·0°	4·4
8	47·6	24·3°	9·4	24·1°	5·9
10	67·0	32·6°	11·3	32·7°	8·0
20	90·53	47·3°	8·7	45·4°	8·4
29	111·8	62·0°	15·0	62·2°	8·0

Second test.

	Sections 4 and 7. Mangrove bark liquors.			Sections 3 and 8. Wattle bark liquors.	
Days.	Tannin.	Barko-meter.	Lime water.	Barko-meter	Lime water.
	grms. per litre.		c.c.		c.c.
2	17·86	8·7	3·8	9·3°	2·8
5	26·8	13·3°	5·6	13·9°	4·2
6	39·86	18·7°	8·2	17·6°	5·3
8	47·31	23·0°	9·0	22·4°	5·4
10	63·63	31·3°	11·2	32·8°	5·8
19	88·75	44·8°	12·8	44·8°	7·8
28	117·06	60·0°	15·3	62·1°	9·6

crease is added to that figure. It will be noted that the increase is higher with the mangrove tannage, but the increase for both tannages is lower than the amount representing combined tannins, and therefore we can assume that as the hide takes up tannin water is expelled.

Sections 1, 2, 5 and 6 were taken from the tan liquors and suspended in water for two hours, drained overnight, scoured on the grain, oiled, and then finished as sole-leather. Sections 3, 4, 7, and 8 were washed in water and allowed to dry. These sections did not receive any oil. The dry rolled sections were what tanners call "firm" but not hard. The mangrove leather was a bright, clean red color. The dry unrolled mangrove-tanned sections were not inclined to a brittle grain, so that scouring is not a necessary factor in the finishing process.

Analytical Results.

The analytical results are worked out on a leather free from fat. The sum of water, total solubles, combined tannin, and hide-substance is 100%. The nontannins are very low, suggesting that the total solubles include free tannin, which was originally combined tannin. Total solubles were extracted from the leather shavings at a temperature of 45° C. The time for extraction was three hours. Previous experiments with pine and wattle barks show that the degree of tannage is low for these mangrove and wattle tests. This difference is partially explained by the fact that we used a thicker hide for this experiment. Another matter would be the age of the leather. For the pine bark experiment the leather was not analyzed until ten months after it was removed from the tan liquors, but for this experiment the same work was all completed within one month. It has been proved* that the catechol tannins, both free and combined, are gradually changing in the air-dried leather. Probably this change adversely affects the solubility of these substances and the natural result would be a lower figure for total solubles. When leather is placed in water at 45° C. it apparently releases a certain amount of combined tannin, so that, omitting bloom and reds, a final and approximately constant figure might be obtained for mangrove tannins. We carried out a second extraction for Sections 4 and 8, and the usual standard process was repeated daily for four days. The results obtained brought the degree of tannage down to 32.7 for mangrove and 31.8 for wattle; after several days the mangrove (in water 18° C.) was still giving up a little coloring matter, and it seems probable that under these conditions we could have reached 30 as a final figure for both tannages.

Further Experimental Work Necessary.

The stability of the combination of hide-substance and tannin, as shown by the degree of tannage, varies to a considerable extent according to the process of extraction, etc. We took four pieces out of each section, when sampling for analysis, and the samples from the two sections in each group were in the same water bath during the process of extraction; so that the results show differences between the two sections of any one group under approximately constant condition. We have to compare results from leather shavings with results from leather ground in a mill,† and if

TABLE II.

Weight gained during tanning process.

Sections. Tannage.	1. W	5. M.	6. W.	2. M.	3. W.	7 M.	8. W.	4. M.
Pelt weight	100	100	100	100	100	100	100	100
1st Liquor	104·6	101·9	102	102·1	103·4	105·1	104·5	102·8
2nd ,,	105·5	105·0	105·3	105·1	106·1	108·4	109·2	108·9
3rd ,,	107·6	106·5	107·6	106·1	109·1	111·3	112·1	112·2
4th ,,	110·1	109·2	110·5	108·1	110·7	113·3	113·4	114·1
5th ,,	111·4	111·0	111·3	111·0	112·8	116·7	115·2	116·9
6th ,,	112·5	113·0	111·7	113·4	113·1	117·2	116·3	117·5
7th ,,	113·2	114·1	112·3	114·4	113·7	117·7	117·2	118·2
Wash-pit	—	—	—	—	108·4	109·8	108·3	109·9

---

*Report of the Committee of the Soc. of Arts on Leather for Bookbinding; J. Soc. of Chem. Ind., 1901, 819; 1902, 128.

†Leather Industries Laboratory Book.

higher total solubles were obtained from the latter then it would appear as if these tannins produce a very unstable leather. However, we recognize that we must carry out more experiments in connection with this problem of extraction.

From a commercial standpoint the leather weight returns, calculated on the pelt and green-salted weights, are all in favor of mangrove.

TABLE III.

	1st Test.				2nd Test.			
Section numbers .... Tannage	1. W.	5. M.	6. W.	2. M.	3. W.	7. M.	8. W.	4. M.
Water	14·00	14·00	14·00	14·00	14·00	14·00	14·00	14·00
Total solubles	20·05	17·31	20·00	19·52	16·54	15·91	18·6	20·31
Non-tans	3·11	2·55	3·24	2·85	1·93	1·36	2·26	1·89
Tannin	16·94	14·76	16·76	16·67	14·61	14·55	16·34	18·42
Hide-substance	43·84	39·92	42·59	39·09	45·40	38·89	44·71	40·33
Combined tannin	22·11	28·77	23·41	27·39	24·06	31·20	22·69	25·36
Degree of tannage	50·43	72·07	54·97	70·07	53·00	80·23	50·75	62·88
$\frac{\text{Pelt weight} \times 100}{\text{Green weight}}$	116·9	119·9	126·1	122·6	118·7	126·0	129·9	126·8
$\frac{\text{Leather weight} \times 100}{\text{Green weight}}$	76·35	85·56	80·87	85·45	68·8	80·19	63·84	70·25
$\frac{\text{Leather weight} \times 100}{\text{Pelt weight}}$	65·31	71·35	64·15	69·73	57·91	63·60	49·12	55·39
Hide-substance in pelt	28·63	28·48	27·32	27·25	26·29	24·73	21·97	22·33
Fats	1·35	1·31	1·09	1·53	0·40	0·31	0·58	0·47
Ash	0·30	0·33	0·35	0·40	0·29	0·22	0·23	0·20

The water absorption test was carried out by placing the unrolled sections in water for various periods as shown below. The leather weight, calculated free from water, is taken at 100, and the water absorbed is shown as a percentage on that figure. In both cases the mangrove absorbed less water than the wattle leather. The sum of the fixed tannin and total solubles is greater with the former than with the latter, and therefore there is less room for water in the mangrove leather, providing other conditions are equal for both leathers.

Sections.	3.	7.	8.	4.
	Wattle.	Mangrove.	Wattle.	Mangrove.
Air-dried leather	19·0	19·7	18·5	18·9
1 Minute	51·1	54·9	49·0	47·2
1 ,, ...	63·7	56·4	64·9	62·4
1 ,, ...	74·3	65·3	77·9	73·3
1 ,, .. .	83·7	72·6	89·9	83·1
1 ,, ...	90·0	79·6	97·9	90·8
1 ,, ...	94·0	83·3	103·9	97·8
1 ,, ...	96·3	86·6	110·0	101·1
5 ,, ...	97·1	88·7	114·7	105·1
20 ,, ...	98·9	91·0	120·7	108·7
13 Hours	103·1	94·1	129·1	113·9
32 ,, ...	108·6	99·2	137·7	120·7

If t_1 is the percentage of water absorbed by a leather containing a small amount of water solubles, t_2 that absorbed by a leather with a large amount of solubles, and t_3 that absorbed by a rolled leather with a large amount of total solubles, then

$$t_1 = \frac{w}{r} 100;$$

$$t_2 = \frac{w - x}{r + y} 100;$$

$$t_3 = \frac{w - (x + m)}{r + y} 100,$$

where w = weight of water absorbed,
r = weight of leather,
x = water displaced by the extra amount of solubles,
y = weight of the extra amount of solubles,
m = the decrease in the volume of air spaces after the leather has been rolled.

Another factor would be an increased amount of insoluble matter such as combined tannin, bloom, and adulterants. Let t_4 be the percentage of water absorbed by a leather with a large amount of solubles and an excess of insoluble matter, then

$$t_4 = \frac{w - (x + l)}{r + y + u} 100,$$

where
l = water displaced by excess of insoluble matter,
u = weight of the excess of insoluble matter.

Water Penetration of Leather.

Leather, like wood, contracts or swells according to the moisture content, and this varies with the different tannages. The rate at which water penetrates the leather is related to the solubility of the substances deposited on the leather fibers. Leather adulterated with an easily soluble substance, like glucose, offers very little resistance to water penetration.

Tensile Strength Tests.

The tensile strength tests were carried out by Mr. H. T. Swain at the Mechanical Engineering Laboratory of the Sydney Technical College. Two pieces were cut from each section as shown on the diagram. Mangrove 4_a and wattle 8_a are placed together for comparative purposes, as they differ only in the barks used for the tanning process. The other groups are shown below, the results being all in favor of the wattle tannage.

Moisture Contents.

The moisture in the leathers is slightly higher with the wattle, and it is not possible to get the four sections with constant percentage of water when they are exposed to changeable climatic conditions. However, the difference is below 1%, and this amount will probably be reduced in future experiments.

Tensile strength test.

-		1st Test.		2nd Test.		3rd Test.		4th Test.	
	Tannage	Wattle.	Mangrove.	Wattle.	Mangrove.	Wattle.	Mangrove.	Wattle.	Mangrove.
	Number	3A.	7A.	3B.	7B.	8A.	4A.	8B.	4B.
	Moisture	13·79	12·82	13·79	12·82	13·2	12·6	13·2	12·6
Original dimensions	Breadth	1·5	1·54	1·5	1·51	1·51	1·49	1·53	1·51
	Thickness	0·25	0·239	0·25	0·240	0·229	0·239	0·255	0·239
	Area	0·375	0·368	0·375	0·363	0·346	0·345	0·390	0·360
Stress in pounds	Total	960	750	1200	920	800	650	810	740
	Per square inch ..	2560	2038	3200	2534	2312	1884	2077	2055
	Total elongation, %	35·6	31·9	33·4	33·4	47·2	38·9	55·6	40·25
	Time	12 min.	10 min.	—	11 min.	15 min.	10 min.	16 min.	13 min.

The leather received no special treatment for this work, and was absolutely free from oil, fat, etc., other than the natural fats in the original hide. The pieces tested were not cut out of the best part of the hide and therefore the results obtained have no value outside of this experiment.

Analyses After Tanning.

Analyses show that these leathers differ after they are tanned, and therefore the results obtained may be influenced by this. The tensile strength of each section is at the maximum in the raw hide, where the physical condition is all that could be desired. A fibrous structure would be at its maximum tensile strength under conditions which allowed the weight to be evenly distributed between all the fibers. The other extreme would be under conditions where the whole of the weight was on a few fibers which break, and then the weight is thrown on another small portion which breaks also, and the result must be a low value for that particular test. It would not be possible to place all the weight on a few fibers until they break, if one were testing a strip of raw hide, where the elastic properties and the general structure are so finely balanced that a strain on any group of fibers causes them to stretch, and then the weight is partially taken up by other fibres, and in this way it is distributed over the whole number before any single fiber breaks. When the raw hide or pelt is placed in tannin solutions the physical condition is changed. It loses to a certain extent its elastic properties. The semi-liquid intercellular substances combine with tannin to form a non-elastic solid. The fibres contract and under certain conditions they may reach a brittle state.

Resistance to Friction.

Proctor states that the tensile strength decreases with increased amounts of fixed tannin, and the same could be said of those water-solubles which dry like tannin extracts to a hard brittle state. However, the variations in fixed tannin, etc., and their influence on these results is a problem which will require special research. If all other conditions were equal we would still expect a difference in tensile strength because the various tannins could combine with the hides in equal proportions by weight, and yet the resulting leathers would differ in their physical properties. The leather with the higher tensile strength will probably offer the greater resistance to friction. Balderston* has described a machine for testing the wear-resistance of sole-leather, and his results show that the loss by friction is at the minimum with a straight chrome and the maximum with a hemlock tannage. Now this is just the position one would expect them to occupy in a series of tests for tensile strength. Hard leather offers a low resistance to friction; the tensile strength is not high, but the water resistance is generally good.

We do not claim to be working the best processes for preparing the pelt or tanning the leather, but we feel certain that this "one hide experimental process" is capable of giving results which should enable tanners to prove the value of a great number of factors, such as various tanning materials, laying away in bark, acidity of liquors, strong liquors, time for tanning, etc.

CLOTHING FROM PEAT ON LARGE SCALE, IS REPORT

Interest is being manifested by American industrial chemists and manufacturers in a report regarding the economic utilization of peat fiber for clothing. An article referring to the new process appeared in "Textile Mercury," Manchester, England, from which it has been reprinted in the daily report of the U. S. Bureau of Foreign and Domestic Commerce as follows:

"A process is stated to have been perfected in Sweden for the manufacture of a strong textile material from peat fiber. The inventor, an engineer named Jegeäus, began to study this process twenty years ago, but was hampered by the fact that the manufacture was much too costly, so that he was unable to turn his ideas to any practical use. Induced by war conditions, however, he resumed his experiments, and has now succeeded in making dress materials from peat on a large scale.

---

*J. Amer. Leather Chem. Assoc., 1916, 11, 429. See J. Soc. of Chem. Ind., 1916, 935.

"The prices of these fabrics are said to be somewhat lower than those for artificial wool, and the durability great. The inventor himself and several other persons are already wearing 'peat' clothing, and a factory for the working of the process is about to be erected."

HIGH EXTRACTIONS FROM LEAD ORES OF LOW GRADE

New Method Resulting From Research Work at U. S. Bureau of Mines Experiment Station Has Many Advantages.

At the Salt Lake City, Utah, Experiment Station of the Bureau of Mines, Department of the Interior, Mr. A. E. Wells, metallurgist in charge, reported as follows to the Washington office of the bureau:

The most successful results of the metallurgical research branch during the month were with low-grade lead ores which have failed to yield to flotation or leaching processes described in previous reports. By mixing these ores with sodium chloride and heating to temperatures of about 800° C., high extractions can be obtained with the lead irrespective of the type of gangue in the ore. The lead volatilizes as a chloride and any silver or gold present is likewise volatilized. These chlorides are precipitated from the fume by the use of the Cottrell precipitator.

The precipitated lead chloride after a mixture with lime and a small amount of reducing agent is heated to a red heat, when a slag of calcium chloride and metallic lead is formed. The calcium chloride is an advantageous substitute for sodium chloride in the first operation and from 50 to 75° of the chlorine is recovered in this manner. This process will have the advantage of producing bullion from either oxides or sulphite ores in localities which do not contain sufficient water for milling purposes. Cost calculations indicate a considerable possibility of this process being cheaper than water concentration followed by smelting.

J. Early Wood, Inc., Now Controls L. & R.

J. Early Wood, Inc., chemicals, colors, etc., have taken over the sales control of the L. & R. Organic Products Company, of Elizabeth, N. J., manufauturers of nigrosines.

New Chemical Factory in Jersey City, N. J.

The work of construction has begun on a factory for chemicals to be erected in Jersey City, N. J., by the Natural Products Refining Company at a cost of $10,000.

Eastern Talc Company Incorporates.

The Eastern Talc Company, of Portland, has been incorporated under the laws of Maine, with a capital stock of $750,000.

TENNIS STAR BECOMES INDUSTRIAL CHEMIST

R. L. Murray, Member of "First Ten," Enters Service of Hooper Company.

To those not already acquainted with the fact, the news that Robert Lindley Murray, one time Californian and now a resident of the East, is a chemist with the Hooker Electrochemical Co., manufacturers of caustic soda at Niagara Falls, N. Y., will be of considerable interest.

Murray, as all good tennis players know, occupies the fourth position in our national ranking—and to be fourth in that hallowed Hall of Tennis Fame known as the "First Ten," makes a man high among mortals for the rest of his life.

(Courtesy of "American Lawn Tennis.")
Robert Lindley Murray.

"Murray the Meteor" is his newspaper name, as McLoughlin's is "The California Comet"—but as Murray is slightly the "meatier" of the two—well, let it pass at that.

His serve, since becoming a full-fledged industrial chemist, blazes through the air like blue—vitriol and scorches the greensward when it hits, in fact so much so that the court is full of brown, seared spots after every match. Rumor hath it that there will be "no holding" Murray this year, for it has been reported (in strict confidence, of course) that he has succeeded in producing a synthetic catgut from cellulose which, when strung upon his racket, will impart to the flight of the ball a series of twists, curves and parabolas unparalleled in tennis annals. This, added to his blinding speed, is calculated to place him No. 1 in the 1917 ranking of tennis immortals.

THE DEVELOPMENT OF AMERICAN DYES

M. D. Reeser.

By Myron Drew Reeser*

An Appeal for Additional Government Support of the American Dye Industry Is Herein Made by Mr. Reeser, Who Declares That Today, Thanks to American Chemists, We Are Absolutely Independent of Germany So Far As the Necessary Basic Colors Are Concerned, and That With Proper Assistance During the Critical Period Following the War, American Manufacturers Can Place Themselves in a Position Where the Domestic Dye Market Can Never Again Be Dominated by Foreign Products.

IT is evident that this country is now facing one of the most crucial periods in its history. War encircles the world. In our hearts the hereditary spirit of patriotism is awakened. War is not a new experience to the American people. It is fraught with painful memories. Many a heart goes back in thought to the South where some loved one sleeps under the sod. Memories of other crucial periods are a stimulus to patriotic expression. Out of the battlefields of the South came the dawn of eternal brotherhood and unity. The price of war is devastation. Life, Art, Commerce are melted in the pot of hate. Out of the night is born the dawn of hope. Commercial activities are resumed. From blackened ruins huge structures are conceived. The sabre is forsaken for the plow. The minds of men, lately bent upon destruction, are united in construction.

Unity in construction is the vital point to be sought in the permanent establishment of any commercial effort. Not unity of mind conceived and born of war, but unity born of purpose. War has come. The greatest safeguard against war is preparedness. Competition is bound to come later. Germany will enter the color field, but never again will her iron hand hold this industry completely within its grasp. Since actual achievements prove that we are able to meet the color emergency, would it not be well to consider the following:

Secret of Germany Dye Supremacy.

What made Germany the dominating factor in the color industry? Was it those chemists who, over half a century ago, conceived the unlimited possibilities of the coal-tar industry with trained men, fostered by the government, money, laboratories and unlimited time at their disposal? Or was it the systematic development of many branches of the coal-tar industry of which colors formed only a part? All of these were bricks in the structure; but the secret was unity. Could such a unity of purpose ever be established in this country?

It is my firm belief that it could, and each month brings it nearer. Now that we have entered the war, would it not be well to forget all differences and to co-operate in commercial preparedness? It is safe to say that few if any chemists in the world could have done as much in such a short time, and under such trying circumstances as have American chemists. Today we are absolutely independent of Germany for the necessary basic colors and each month brings us new and encouraging developments. True, there are many of the more delicate shades yet to be perfected, but given one quarter of the time that was devoted to this industry in Europe, we will equal the world in range of colors and output.

Vast Potentialities in Coal-Tar Industry.

The American manufacturer of dyestuffs has profited by the war and the subsquent period of panic and trade cessation. Confidence influenced those men who spent millions in this industry, and confidence is the stabilizer of that industry today. War has come and for a time militarism will be the first consideration. But after the war we must turn to the generals who lead the armies of commerce. In the coal-tar industry and its subsequent development lie the possibilities of a great commercial unit. The demand for actual colors has been so urgent that many small plants have turned their efforts to this end when more attention to other branches might have been more advisable.

Recent developments in the photographic chemical field are indeed surprising. There seems, however, to be a desire for secrecy among the few companies entering this particular branch of the industry.

Closer Unity of Smaller Companies.

Perhaps this is wise, but each development, if immediately brought to the attention of those engaged in the coal-tar industry, is a means of strengthening the faith of consumers in the ability of American manufacturers.

There is not this hesitancy with regard to the larger manufacturers, as their products, when placed upon the market, must maintain the good name of the manufacturer.

---

*From The Dry Goods Guide.

This does not mean that there is a lack of co-operation between the large companies engaged in this industry, for that statement would be untrue.

A closer unity of the smaller companies is essential, for they lack sufficient funds to cope with the enormous expenditures necessary. It is a source of unlimited pleasure to converse with men who have led their organizations through the many difficulties attending the establishment of this industry. The lack of antagonistic feeling is surprising. Unlimited commendation is due them for their efforts in meeting the sudden demands of the textile and allied trades.

Today their plants are in a position to play a large part in the making of necessary war materials, such as high explosives, detonators, flame enveloping liquids and asphyxiating gases. They would undoubtedly be appealed to by the Red Cross for antiseptics, anæsthetics and pain-reducing drugs. The equipment of a large dyestuff manufacturing plant would be of more actual use, perhaps, than that of munition factories, for even though its total output might be less, its collective scope would be greater. If these large dyestuff manufacturers are ready to lend themselves to the government, why does the government fail to give them more assistance?

Government Can Help.

Foreign nations have always co-operated with those engaged in the coal-tar industry, and now in this reign of hate and strife we are told that disinfectants and hospital supplies are being turned out in enormous quantities by these plants. Our government would do well to emulate Germany in this respect. In conversation a few days ago, the statement was made that the American manufacturer of dyestuffs had not done enough to warrant protection by his government.

Much comment is heard regarding the attitude of certain well established chemical houses in jeopardizing the good will of their name through purchasing dyestuffs from doubtful manufacturers. There was apparently unlimited opportunity to make money, and this was undoubtedly the factor which led to their entering the color field. The promiscuous buying of dyestuffs regardless of circumstances is dangerous. This does not mean that the small manufacturer of colors is not reliable, but that the desire to accumulate wealth often overcomes the importance of establishing a name for quality and uniformity of their products. The output of colors today is very nearly equal to this country's total consumption. This output is controlled by companies which have established in past years a well deserved reputation. There are over one hundred coal-tar dyes now being produced in this country and the standard maintained is gratifying.

American Achievements Find Support.

The textile trade is unanimous in voicing its appreciation of the efforts of American manufacturers and is making contracts which should hold long after the termination of European hostilities. These American manufacturers are able to engage chemists from the large universities of the United States, and this assures the textile trade of uninterrupted service. A scholarship from these institutions is today on a par with any in Germany, and in most cases the strides in research work have been greater. The manufacturer of colors is placing his faith in the efforts of these younger men to carry on the industry, and that faith is assuredly well placed.

German dyestuff manufacturers have a capital of one hundred million dollars and German dye-making plants were for the most part free to debt. They had forty years of technical experience and unlimited scientific laboratories at their disposal. Germany also had one of the most wonderful and far-reaching selling organizations ever conceived. Today the American chemist is protected by ample capital for experimental expenditure. His training has been more rapid because of necessity. He will have back of him an American selling organization and the actual experiences of foreign representatives. The American manufacturer will broaden his field of operation and even now representatives are being placed in foreign cities.

Opportunities for Chemists Unlimited.

The field of opportunities presented to the young chemist is unlimited. The serious circumstances which confronted those engaged in this industry before the war are no longer a hindrance, for now this country is producing more raw materials than could be consumed in normal times. By this is meant the principal raw materials, such as toluol, benzol napthaline and kylol. When the need of other materials is urgent there is no doubt that American manufacturers will meet the demand. The raw material question has been solved and never again will it stand in the way of development.

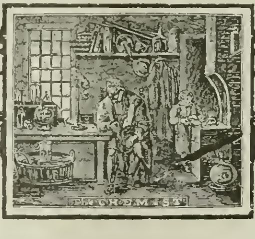
There has been a ready spirit of co-operation manifested by the maker of machinery, and judging from his efforts one can safely say that he has ability to a surprising degree. Raw materials, brains, money, equipment, all of these are at the disposal of this industry, and with governmental protection added, the ultimate result would be more readily attained. Certainly the government has helped, but an industry so vital to the commercial prosperity of this country needs still further government backing.

MARKET DESIRED FOR MANGANESE ORE.

An American consular officer in South Africa has transmitted the name and address of a person who desires to get in touch with consumers of iron ore in the United States, as he desires to market 500 to 1,000 tons of this product. The person's name can be obtained at the Bureau of Foreign and Domestic Commerce or its district or co-operative offices by referring to file No. 85343.

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.



ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

J. T. T. Fertilizers are now sold on specified and guaranteed analyses. If your products do not come up to these standards they will be returned. I would advise you to have an analysis made of each batch before sending it into the trade. (41)

C. G. For the determination of sulphur and phosphorus in your steel samples, only borings should be forwarded. Six or eight ounces will be required for the tests.

P. H. It is very necessary to determine the water content of sulphurated cod liver oil, which is used in the manufacture of leather, as much of it contains upward of 30 per cent. In sending samples for analysis forward about four ounces. (2) This subject is covered fully in another part of this issue of "The Chemical Engineer."

A. T. By stating for what purpose the sample is intended much time and expense will be saved.

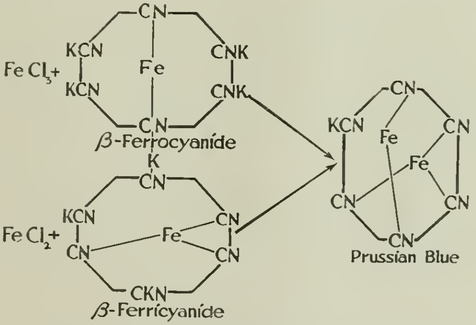
E. E. S. All samples for chemical analysis or analysis and working formulas, as well as research work in general, should be addressed to Charles B. Davis, care of The Chemical Engineer, 118 East 28th Street, New York.

B. A. B. It is a fact that many dyes were brought over on the Deutschland, but no shortage is to be felt in the future for these products, since our own chemists are now turning them out in large quantities. (43)

A. H. A water used for your special process should have a composition suitable for its purpose. If the supply on hand does not meet these requirements, it can be softened or hardened as the case may be and made fit. A gallon sample will be required for the analysis. (50)

P. A. F. If you are uncertain as to the quantity of sodium benzonate your tomato stock contains it will be well to send a four oz. sample for the exact determination of this preservative, as ½ of 1% is the amount now allowed. (48)

A. A. T.—Your request for the latest chemical formula of Prussian Blue has been looked into very carefully, and is as follows:



S. C. B. Angostura bitters contains from 15 to 20 ingredients, and will require a week or so for its complete analysis. A working formula can be supplied for this or any other commercial product you may wish examined. (36)

C. K. Temperance drinks are either non-alcoholic or contain not more than 2 per cent. alcohol, according to the laws of the various states. If you will tell me into which state or states your particular drink is to be shipped I can furnish the exact strength of alcohol allowed. (47)

D. D. When sending the machine and cylinder oils your mention in your last letter kindly forward pint samples, as small quantities will not allow of complete analyses. (26)

T. M. If your paint does not dry it may be due to too high boiling point solvent or too much water. These defects can be detected easily, at small cost, by chemical analyses. (33)

Charles B. Davis

DISTILLATES

News Notes of Chemical and Allied Industries

Missouri-Arkansas Oxygen Co. Created.

With a capital stock of $25,000, the Missouri-Arkansas Oxygen Co., of St. Louis, has been incorporated by Rudolph Best, Oscar G. Reichardt, Louis Rosen and several others.

Will Develop Graphite Properties.

For the development of graphite properties near Pyriton, Ala., The Great Southern Graphite Company will maintain a plant with a daily capacity of 300 tons.

Anhydrous and Aqua Ammonia.

With a capital stock of $650,000, the Alcohol Products Co., of Newark, N. J., has been incorporated under the laws of that state to manufacture anhydrous and aqua ammonia, and chemicals, by H. T. Edgar, H. M. Miner, Brooklyn, and H. W. Haines, Millburn.

Compressed Gasoline Oils.

A process of compressing gasoline oils from casing and head gas will be undertaken by Gasoline Producing Corporation, Wilmington, Del., which has recently been incorporated with a capital of $1,000,000.

New Offices for National Aniline.

Application to establish offices in Charlotte, N. C., has been filed by the National Aniline and Chemical Company, of New York City.

Bronzo Alumina Corporation.

Aluminum, silicon, bronze and iron castings will be dealt in by the Bronzo Alumina Corporation, of Tonawanda, New York, which has recently been incorporated with a capital of $16,000 by F. A. Redner, J. E. Kaufman and J. H. Willing, 141 Masten Street, Buffalo.

De Vore Chemical Company.

Chemicals will be manufactured by The De Vore Chemical Company, Columbus, Ohio, which has been incorporated with a capital of $50,000 by P. R. De Vore, P. F. Wilkinson, C. E. Williams, W. C. Shacklett and J. E. Waddy.

New Paint Manufacturers.

Paints, stains, etc., will be manufactured by the Mansfield Paint Company, Mansfield, Pa., the incorporation of which with a capital of $150,000 has been announced. The incorporators are C. H. Rane, Mansfield, Pa.; D. D. Buck, George W. Dillman, all of Wilmington, Del.

Sunbeam Chemical Company.

The Sunbeam Chemical Company, of Chicago, has been incorporated under the laws of Illinois with a capital stock of $25,000.

French Perfume Increases Stock.

An increase in its capital stock of from $20,000 to $30,000 has been made by the French Perfume, Medicinal and Aniline Manufacturing Company, Inc., of New York.

Chemechlec Company Incorporated.

The Chemechlec Company, of Camden, N. J., has been incorporated under the laws of that state by Frank A. Lane, Frank A. Rowcroft and H. Lindsay Vogel.

To Build Coke Oven.

Plans are being discussed by the Monongahela Traction Company, of Fairmount, West Virginia, to build a by-product coke oven in that state.

Fuller's Earth Company Organized.

The Medina Fuller's Earth Company, of San Antonio, Texas, has been incorporated with a capital stock of $100,000 by O. T. Gregory and E. D. Henry, of that city, and L. R. Parker, Aurora, Ill.

Dyestuffs, Paints and Drugs.

The K. F. G. Products Company, New York, has been incorporated with a capital of $10,000 to deal in chemicals, dyestuffs, ores, compounds, paints and drugs. The incorporators are S. Greenberg, I. Lowenbraun and B. L. Karliner, 116 Nassau Street.

Petroleum Light and Heat Co.

Petroleum will be manufactured and produced by the recently incorporated Petroleum Light and Heat Company, Wilmington, Del. The capital of the new concern is $50,000, and the incorporators are M. L. Rogers, L. A. Irwin and H. W. Davis, all of Wilmington, Del.

Gas, Oil, Etc.

Empire Refineries, Inc., Augusta, Maine, has been incorporated with a capital of $5,000,000 to deal in gas, oil and other mineral bearing properties.

Chemists and Chemical Manufacturers.

Pittsburg-Utah Potash Fertilizer Company, Wilmington, Del., has been incorporated with a capital of $500,000 to carry on the business of chemists and chemical manufacturers. The incorporators are F. D. Buck, George W. Dillman and M. L. Horty, local Wilmington incorporators.

FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained Directly From the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More than One on Separate Sheets.

Brewery Supplies.

23982.—A representative of American firms in France, with an office in the United States, desires to be placed in communication with American manufacturers and exporters of brewery supplies and machinery. References.

Cattle Hides; Sugar; Cereals.

23949.—A man in Spain desires to be placed in communication with American manufacturers and exporters of cattle hides for furniture, carriages, boots and shoes, etc.; codfish, sugar, cereals, and sausage casings. Correspondence may be in English.

Copper Sulphate.

24122—A man in France is in the market for large quantities of sulphate of copper for spraying vineyards. Quotations should be made c. i. f. Bordeaux, if possible. References. Correspondence should be in French.

Copper Sulphate.

23930.—A firm in Spain desires to purchase sulphate of copper, 98/99 per cent. Quotations should be made c. i. f. destination. Cash will be paid. Goods should be put up in barrels. Correspondence may be in English. Reference.

Analyzed Granulated Sugar.

23947.—A merchant in Italy is in the market for best quality granulated sugar in weekly consignments. Analysis of the sugar is required. Quotations should be made c. i. f. Genoa. Payment will be made by cash against shipping documents. Correspondence may be in English. References.

Cement Mosaic Colors.

23936.—A manufacturer in Spain is in the market for colors used in the manufacture of hydraulic cement mosaic. Quotations should be made c. i. f. destination. The material should be packed in small barrels. Correspondence should be in French or Spanish. References.

Cotton; Rosin; Caustic Soda.

23988.—A company in Brazil desires to secure an agency for the sale of cotton, rosin, and caustic soda. Correspondence should be in Portuguese or Spanish. References.

Bicarbonate of Soda.

24114—A man in Canada desires to purchase bicarbonate of soda in kegs, barrels, and casks, in carload lots, or secure an agency for the sale of same. Quotations should be made f. o. b. shipping point. Goods should be shipped c. o. d. Correspondence may be English. Reference.

Tanning Extracts.

24101—A firm in Spain wishes to secure an agency for the sale of tanning extracts. Quotations should be made c. i. f. destination. Correspondence should be in Spanish or French. References.

Indigo Bluing.

23934.—A man in Spain wishes to secure an agency for the sale of indigo bluing. Quotations should be made c. i. f. destination or Barcelona. Payment will be made against shipping documents in Spain. Correspondence may be in English. References.

Caustic Soda.

24031.—A firm in Switzerland is in the market for 66,138 to 110,230 pounds of caustic soda 125 degrees. Quotations should be made c. i. f. Genoa. Payment will be made against shipping documents. The soda should be put up in air-tight, soldered, sheet-metal drums of 661 to 881 pounds. Correspondence should be in German. References.

Sphygmomanometers.

24037.—A doctor in a French insular possession desires to purchase sphygmomanometers. He also wishes to receive catalogues from American manufacturers and exporters of surgical instruments and physiological apparatus. Cash will be paid. Correspondence may be in English, but French or German-French is preferred.

Scientific Apparatus.

23966.—A firm in Spain desires to buy scientific apparatus, such as drawing instruments, metric measures and scales, surveying instruments, calculating slide rules, thermometers and barometers, telescopes, microscopes, and chemical balances and weights, or secure an exclusive agency for the sale of same. Correspondence may be in English. Reference.

Soap Ingredients.

23957.—A firm in Argentina desires to purchase bright galvanized corrugated iron sheets of good quality, 8/3 by 24 gauge, in 6 to 10 foot lengths. The firm also wishes to represent American manufacturers and exporters of pitch pine, rosin, and ingredients for the manufacture of soap, such as caustic soda, soda ash, silicate of soda, bicarbonate of soda, chloride of lime, soda crystal, and cocoa oil. Quotations should be made c. i. f. destination. Payment will be made by cash against documents through local bank. The galvanized sheets should be packed in skeleton felted cases. Correspondence may be in English. Reference.

APRIL PRICES OF CHEMICALS, ETC.

The New York Wholesale Market on April 16

CHEMICALS, ORGANIC.

Acetanilid, lb.	.39	@	.40
Acetic acid, 28 per cent	4.15	@	4.30
Acetic acid, glacial	.28	@	.30
Alcohol, 190 U. S. P.	2.84	@	2.85
Alcohol, denatured, bbls.	.70	@	.72
Alcohol, wood, 95 per cent	1.00	@	1.02
Alcohol, wood, 97 per cent	1.05	@	1.07
Amyl acetate	3.60	@	3.65
Benzoic acid, Ex Toluol	7.50	@	7.75
Carbolic acid, drums	.43	@	.45
Carbon tetrachloride	.16	@	.16½
Chloroform	.60	@	.62½
Citric acid crystals	.72	@	.77
Glycerine, C. P. drums	.55	@	.56
Glycerine, cans	.56	@	.57
Glycerine, dynamite	.54	@	.55
Pyrogallic acid, resublimed	3.15	@	3.25
Pyrogallic acid, crystals	2.90	@	3.10
Salicylic acid	.80	@	.85
Tannic acid, technical	.65	@	.70
Tartaric acid, crystals	.76	@	.85

CHEMICALS, INORGANIC.

Acetate of lime, gray, 100 lbs.	4.50	@	4.55
Alum, ammonia, ground	4.20	@	4.25
Alumina sulph, iron free	.03½	@	.04
Ammonia aqua, 26 deg., lb.	.06	@	.06¼
Barium chloride	90.00	@	95.00
Barium nitrate	.14	@	.16
Blanc fixe, paste	.03	@	.03½
Blanc fixe, powder	.04	@	.04½
Blue vitriol, carlots	.09½	@	.10
Blue vitroil, powdered	.13½	@	.14
Borax, crystals	.07¾	@	.08
Brimstone, ton	45.00	@	....
Caustic soda, 76 per cent	.04½	@	.04¾
Calcium sulphate	.10	@	.20
Glauber's salt			
Nitric acid, 40 degree, 100 lbs.	6.50	@	6.75
Phosphoric acid, 50 per cent	.20	@	.22
Potassium bichromate	.36	@	.37
Potassium bicarbonate	1.25	@	1.40
Potassium chlorate, crystals	.59	@	.60
Potassium cyanide, mixture	1.00	@	1.15
Sodium acetate	.10	@	.13
Sodium bicarbonate	.02	@	.03½
Sodium benzoate	7.50	@	7.75
Sodium nitrate	.18	@	.20
Sodium phosphate	.05	@	.06
Sodium prussiate	.30	@	.35
Sodium chlorate	.25	@	.26
Sodium salicylate	.85	@	.90
Sodium sulphide	.02	@	.02½
Sulphuric acid, 66 deg.	1.75	@	2.00
Sulphur, flowers	2.65	@	2.95
Tin bichloride	17½	@	.18
Tin oxide	.59	@	.61
Zinc oxide	.12	@	.14

DYE MATERIALS.

Annatto, cans	.32	@	.33
Aniline, oil	.28	@	.32
Aniline, salt	.31	@	.38
Albumen, blood	.50	@	....
Albumen, egg	.82	@	.88
Albumen, egg yolk	.30	@	.32
Beta naphthol, sublimed	.90	@	1.00
Carmine, No. 40	4.40	@	4.50
Cochineal, silver, lb.	.51	@	.52
Cochineal, black, lb.	.62	@	.63
Gambier, lb	.15	@	.15½
Indigo, madras, lb.	1.10	@	....
Logwood extract, lb.	.11	@	.15
Madder, Dutch, lb.	.24	@	.25
Myrabolans	40.00	@	45.00
Paranitraniline	1.30	@	1.35
Soluble Blue, lb. powder	.75	@	.88
Sulphur, black, lb.	.60	@	.90
Sulphur, brown, lb.	.25	@	.50
Zinc dust, lb.	.22	@	.28
Zinc oxide, lb.	.12	@	.14
Zinc sulphate, lb.	.06½	@	.07

ESSENTIAL OILS.

Almond, bitter, lb.	14.00	@	16.00
Amber, rectified	1.50	@	1.60
Anise	1.07½	@	1.10
Camphor	.16	@	.20
Cinnamon, lb.	....	@	20.00
Clove, cans	1.40	@	1.45
Cubeb	5.15	@	5.25
Ginger	8.00	@	....
Limes, distilled	2.15	@	2.75
Pennyroyal, American	1.65	@	1.85
Peppermint, tin	2.20	@	2.30
Spearmint	1.75	@	1.90
Wintergreen, synthetic, oz.	.75	@	....
Wormwood, oz.	3.25	@	....

OILS.

Codliver, Newfoundland, bbls.	63.00	@	70.00
Castor, crystal, lb.	.21	@	....
Castor, "A.A."	.20	@	....
Castor, No. 3	.19¾	@	....
Corn, crude	13.31	@	....
Corn, refined	14.51	@	14.61
Cocoanut, Ceylon	....	@	.18
Fusel, Haarlem	6.00	@	....
Menhaden, light	.79	@	.80
Menhaden, brown	.75	@	.76
Menhaden, winter	.82	@	.83
Menhaden, extra	.84	@	.86
Myrbane, drums	.19	@	.20
Myrbane, cans	.20	@	.21
Olive, yellow, green	1.55	@	1.60
Olive, edible	2.25	@	3.00
Paraffine, high viscosity	.29½	@	.30
Paraffine, 903 sp. gr.	.21½	@	.28
Rosin, first run	.38	@	....
Rosin, second run	.49	@	....
Rosin, third run	.59	@	....
Rosin, fourth run	.69	@	....
Soya bean	.13	@	.13½
Spindle, filtered	.28	@	.35
Sesame, foreign	2.00	@	2.25
Sperm, bleached	1.10	@	1.12

THE CHEMICAL ENGINEER

VOL. XXV. MAY, 1917 No. 3

Published Monthly by the

McCready Publishing Company.

ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

LAURANCE T. CLARK, Editor
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.

Single Copies, 25c.

Statement of the Ownership, Management, etc., Required by the Act of Congress of August 24, 1912,

Of the Chemical Engineer, published monthly at New York, N. Y., for April 1st, 1917.

County of New York, State of New York, ss.

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Robert H. McCready, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Chemical Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership. management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, McCready Publishing Co., 118 East 28th St., N. Y.; editor, L. T. Clark, 118 East 28th St., N. Y.; managing editor, none; business manager, R. H. McCready, 118 East 28th St., N. Y.

2. That the owners are: C. J. O'Brien, 22 North William St., N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

ROBERT H. McCREADY.

Sworn to and subscribed before me this 30th day of March, 1917.

FREDERICK PFISTER.

(My commission expires March 30, 1917.)

CONTENTS, MAY, 1917

Portrait of Thomas H. Norton................ 82

Dr. Thomas H. Norton to Edit Dye Department For the Chemical Engineer................ 83

The Potash "Noose"........................ 84
Thomas H. Norton.

The Industrial Chemist and the Fertilizer Crisis.. 86
H. Clay Lint.

Possibility of the Recovery of Potash from Banana Stalks 89

"Nitron" as a Gravimetric Reagent for the Analysis of Substances Used in Explosives.... 90
W. C. Cope and J. Barab.

Bibliography of Literature on "Nitron" (Prepared for Use in Connection with Foregoing Article). 94

Ultra Violet Light: Its Application in Chemical Arts 95
Carleton Ellis and A. A. Wells.

Accurate Silica Determination in Commercial Analysis 100
F. G. Hawley.

Development of Raw Soda Deposit in East Africa 103

Manufacturing Tests of Cotton Fumigated by Hydrocyanic-Acid Gas 104
William S. Dean.

Pure Oxide of Uranium Prepared By New Method 109

Government Report on Shales Yielding Petroleum 109

The American Coal-Tar Color Industry: Its Development and Permanency in the United States 110
I. F. Stone.

Electrochemists Hold Thirty-first General Meeting in Detroit 113

Lalang Grass as a New Source of Paper Pulp.... 114

Leeds Chemical Firm Buys Coal-Tar Plant...... 114

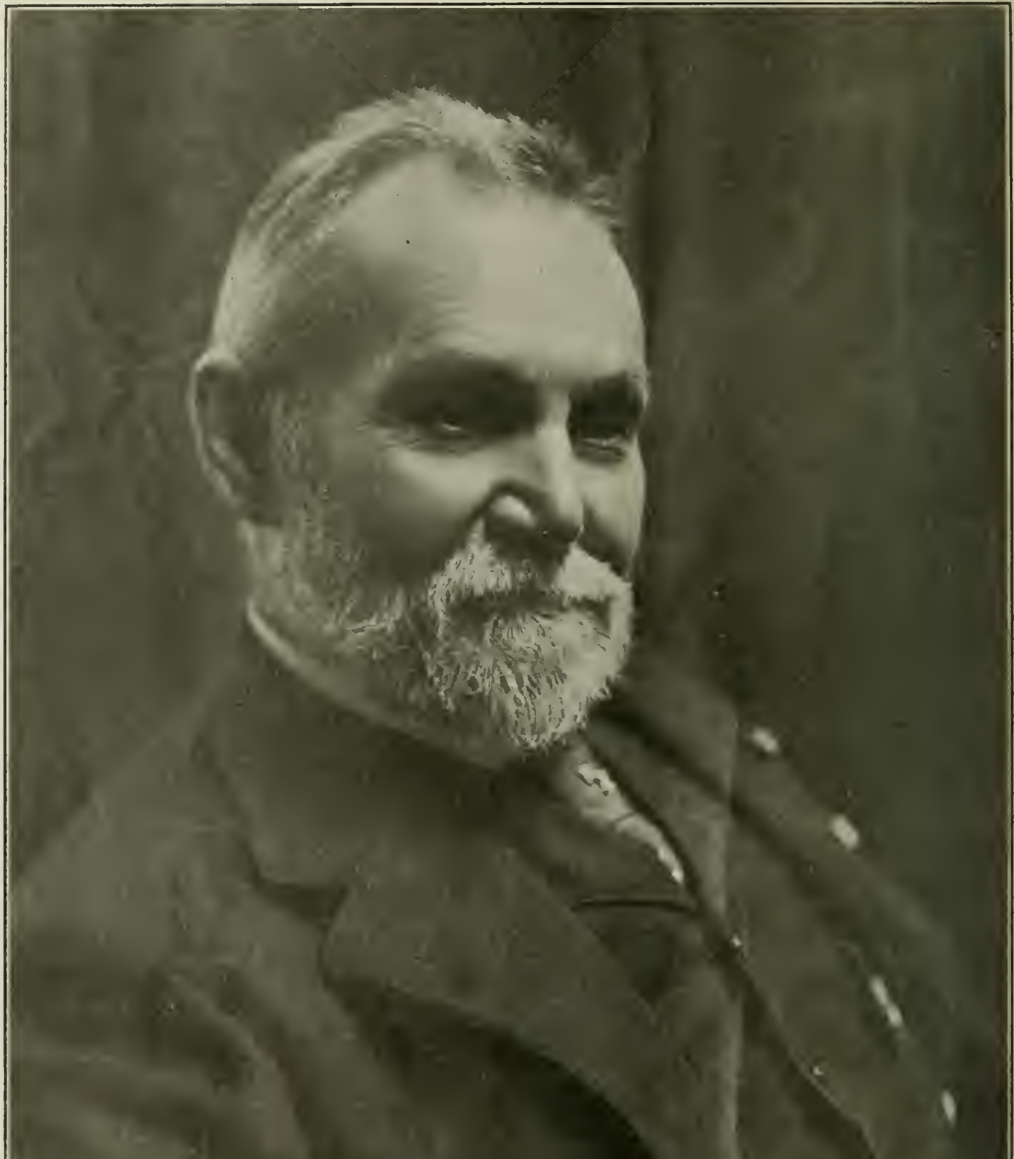
Refractories and Glass Mixtures Being Studied.. 114

Chemical Investigation, Efficiency and Control... 115
Conducted by Charles B. Davis.

Distillates: News Notes of Chemical and Allied Industries 116

Foreign Trade Opportunities................. 118

May Prices of Chemcials.................... 120



THOMAS H. NORTON, Ph.D., Sc.D.
See Announcement on Opposite Page.

DR. THOMAS H. NORTON TO EDIT DYE DEPARTMENT FOR THE CHEMICAL ENGINEER

In the history of American manufacturing industries there is nothing comparable, in rapidity of evolution, with the American coal-tar chemical industry.

In all its manifold ramifications, from the production of crude materials, the refining of these crudes and their transformation into intermediates, to the manufacture of a large variety of staple dyestuffs, synthetic medicinals, photographic chemicals, etc., and the production of vast masses of high explosives, this young industry has suddenly emerged from its swaddling clothes and quickly sprung to man's stature.

There is a strongly expressed opinion on the part of many identfiied with this industry that the time has arrived for it to possess its own organ—a journal in which its interests will be fully represented and defended.

To meet this legitimaate demand, the publisher of the Chemical Engineer has decided to devote a large share of its space to a department occupied exclusively with coal-tar chemistry. Every phase of the industry, scientific, technical and commercial, will receive full and adequate treatment. The needs of producers and consumers will be studied with equal care. Coal-tar colors will necessarily be a dominant feature, but consideration will be given to the so closely allied natural dyestuffs. No pains will be spared to make this department fully equal in practical value to the British, French and German periodicals devoted to the interests of makers and users of artificial and vegetable colors. Special attention will be given to the mechanical phases of the problem, to all devices simplifying and standardizing the production of coal-tar crudes, intermediates and finished colors, or other synthetic products, as well as the use of coal-tar compounds in dyeing and in the arts generally.

The publisher of the Chemical Engineer takes pleasure in announcing that he has secured as editor of this department Dr. Thomas H. Norton, who has labored so actively during the past two years under the auspices of the Department of Commerce to stimulate, aid and further the expansion of this new national industry.

Dr. Norton will be assisted by a corps of Associate Editors, including several prominently identified with the building up of the American coal-tar chemical and color industry, and others equally prominent among the consumers of its products. The co-operation of able foreign correspondents has also been assured.

To members of the chemical fraternity in general, and to all who are connected with the production of dyestuffs both here and abroad, Dr. Norton needs no introduction.

As a special agent of the Bureau of Foreign and Domestic Commerce, at Washington, and author of the complete census of artificial colors used in this country entitled "Artificial Dyestuffs Used in the United States," his work has attracted international attention. He is an investigator of unusual experience and an author of repute on chemical and industrial topics. He has published a great number of papers containing the results of his researches in mineral, organic and technical chemistry. Among the books from his pen are:—"The Application of Aniline Colors to the Dyeing of Leather," 1877; "Chemical Exhibits of the Paris International Exposition of 1878"; "The Utilization of Atmospheric Nitrogen," 1913, regularly used as a textbook both here and abroad. "The Chemical Industries of Belgium, Holland, Norway and Sweden," 1913, translated into German; "Dyestuffs for American Chemical and Other Industries," 1915; "Cottonseed Industry in Foreign Countries," 1915; "The Dyestuff Situation," 1915; "Potash Production in California," 1915; "Potash from Kelp," 1915; "The Dyestuff Situation," January, 1916—second edition, May, 1916.

Dr. Norton was born in Rushford, N. Y., June 30, 1851, and was graduated at Hamilton College in 1873 as valedictorian, and first prize man in classics, mathematics, chemistry and physics. He studied at the University of Heidelberg under Bunsen and Kirchoff in 1873-1875, and won his Ph. D. there. He was a student at the University of Berlin in 1876-1877 with August Von Hofmann, in whose laboratory the first aniline color was discovered, and was a student at the University of Paris in 1877-1878. During these years he made journeys on foot of more than 12,000 miles in Europe and Western Asia, and was the first to traverse Greece, Palestine and Syria on foot alone.

For five years, from 1878 to 1883, he was manager of the chemical works of the Compagnie Generale des Cyanures of St. Denis, near Paris, manufacturing dyeing materials. Returning to this country he was for 17 years professor of chemistry at the University of Cincinnati, 1883-1900. In the latter year he was appointed by President McKinley to establish an American consulate at Harput, Eastern Turkey. During 1904 Dr. Norton engaged in a special investigation of the Armenian situation, and in the winter of 1904-1905 he was sent on a diplomatic mission to Persia by President Roosevelt. In 1905-1906 he was American consul at Smyrna, and from 1906 to 1914 American consul at Chemitz, Saxony. Here he was largely occupied with textile problems in connection with the application of colors to fabrics. In 1911-1912 he was detailed on special service for the Department of Commerce to study the chemical industries of Europe. The results of his investigations are found among the special monographs already mentioned.

THE POTASH "NOOSE"

By THOMAS H. NORTON, Ph. D., Sc. D.

Despite the Gloomy Predictions of One of Germany's Leading Chemists, There Is Not, Dr. Norton Hastens to Assure Us, the Slightest Danger of the Threatened "Strangulation" of Our Food Production Through Inability to Utilize Our Great Natural Sources of Potash. In the Following Article He Describes Where Our Supply Lies, and What Has Been Done to Make It Available.

DURING the first week of May, 1917, Professor Wilhelm Ostwald, of Leipzig, who stands in the very fore-front of Germany's chemists and even philosophers, published the following statement:—

"America went into this war like a man with a rope around his neck, which is in the enemy's hands and is already pretty tightly drawn. With its tremendous deposits Germany has a world monopoly in potash, a point of immense value which cannot be reckoned too highly when once this war is going to be settled. It is in Germany's power to dictate which of the nations shall have plenty of food and which shall starve."

I have a profound respect for Professor Ostwald's scientific attainments, and for his rank as a clear, logical thinker. Yet it is impossible to read the above without seeing in the statement another of the striking examples, so frequent during the past three years, of the apparent inability of highly trained Teutonic minds to correctly appreciate the spiritual and the material resources lying either half hidden or dormant in other races and other lands.

For years the German chemist has firmly maintained the thesis that the magnificent and almost unique deposits of Stassfurt are the sole practical source of potash to meet the world's needs in agriculture and in the arts.

If he grants that potash is widely diffused in the mineral and vegetable kingdoms, he asserts at the same time that it is beyond the possibilities of chemical technology to separate and secure it, in commercial forms, and at costs of production which will ever threaten the dominance of the Stassfurt output. Professor Ostwald's latest utterances would indicate even a disbelief in the ability of foreign chemists to recover potash in adequate amounts, on an industrial scale, quite apart from the cost of production.

It would certainly appear as if our fellow chemists in Germany are totally unaware of the wealth of potash, in this country alone, and of the marvellous efforts being exerted to render it available for the nation's needs during the past two years.

Let us note just how near we are to strangulation from the "noose" of Professor Ostwald's figure, what danger we are actually incurring from the interruption in our customary supplies of potash salts from the Stassfurt mines.

If we were using potash in American agriculture as generously and sensibly as is the rule in Germany and in adjacent countries, notably in Belgium, Holland and Denmark, Professor Ostwald's reasonings would rest upon a better basis. Unfortunately this is not the case. We are only beginning to appreciate the importance of ample rations of potash, phosphoric acid and nitrogen for our growing crops. The American farmer is content to harvest 15 bushels of wheat per acre, while the Dane or German secures double or triple this amount for the same amount of labor.

American agriculture should consume ten times the quantity of potash currently employed prior to the war. The consumption at that time was very unevenly distributed. Thus, the amount of potash per 100 acres of cultivated land regularly used in Florida was 2,131 lbs. In Illinois it was but 12 lbs. In Kansas it was but half a pound.

All told, American farmers were using about 1,000,000 tons of potash salts yearly, and varied industries, notably glass and soap manufacture, required in addition, about 23,000 tons.

Since March, 1915, there has been a genuine "potash famine" in this country, attended by the inevitable dislocation of technical and commercial organization resultant upon a sudden shortage in the supply of a staple article.

The emergency called for prompt and radical action. In a general way it was known that our vast domain contained enormous amounts of potash—present nowhere in such abundance as at Stassfurt—but still in such quantities that the possibility of economic utilization under normal conditions was a farly debatable question.

When quotations for potassium compounds increased to ten-fold the customary rates, American enterprise needed no further stimulus. The problem was promptly tackled from a number of points.

The actual results obtained during 1916 show clearly that this country is destined to have its own potash industry, meeting completely the nation's varied needs, and that at no distant date.

The various phases of the solution of the potash situation may be briefly enumerated.

First and foremost comes the utilization of the enormous amounts of the compound stored annually in the kelp crop of our Pacific littoral. The possible yearly harvest has a value estimated at from $50,000,000 to $90,000,000 as prices ruled in 1913. If it be used as a fertilizer the nitrogen content means an additional increase in value of $30,000,000 to $60,000,000. There is no need of plowing, sowing or cultivating. Nature does it all. Harvesting by means of an aquatic reaper and mower is the sole operation involved. The gathered product, dried and ground, is ready for use as a fertilizer. It can easily compete in the cotton fields of the South and in the varied agriculture of the Atlantic states, with the potash brought from Germany.

A score of factories are now busily engaged in this new industry, located largely along the southern coast of California, but to some extent about Puget Sound.

Much of the product is prepared for direct use as a fertilizer. Some serves as raw material for the extraction of potassium salts to be used in the arts, following the practice along the coasts of Brittany, Norway, Scotland and Japan.

It is the beginning of a grand exploitation of one of the nation's most valuable assets, one which is renewed every year, and not destined to ultimate exhaustion and disappearance, as is the case with our coal veins, the deposits of Chile saltpeter or the mineral occurrences of potash.

The seaweed or kelp of the Atlantic contains a materially lower percentage of potash than is the case with the varieties found in the Pacific. Still the amount present is of great value during the temporary era of abnormal prices. The vast mass of seaweed in the central Atlantic, known as the Sargasso Sea, offers the most tempting field for operations. A campaign is now under way, directed from the Florida coast, for the systematic exploitation of this great bed. A huge barge of concrete is towed to the distant location, with supplies for a year's operations. With the help of auxiliary small craft the kelp is collected and the processes of desiccation and extraction are effected upon the barge, from which the concentrated products are shipped from time to time to American ports adjacent to fertilizer centers. The whole plan is of great interest, combining simplicity, low cost of production and a notable magnitude of operation.

A considerable amount of potash, of a different vegetable origin, has hitherto gone to waste in distilleries using molasses, as a raw material, for fermentation. There are twenty-six such distilleries in the United States and the daily waste has averaged 106 tons of pure potash (K_2O). A process has now been perfected for the complete recovery of this amount in a perfectly dry form, admirably adapted to the needs of the manufacturers of composite fertilizers.

Potash is now recovered as a by-product, in connection with our iron industry. Certain varieties of our Alabama ores contain over 3% of potash. A large proportion of the volatile salts escapes in the waste gases of the blast furnace, and is now systematically collected.

A similar source is encountered in connection with the manufacture of cement from limestones and clays containing appreciable amounts of the alkali. Over one half of the quantity present escapes in the stack gases.

In both cases the Cottrell electrical precipitation process is used with great success in isolating the potash fume from the current of waste gas. It is evident that this clever, but exceedingly simple process is destined to play an important role in establishing upon a firm basis the American potash industry.*

One leading line of active investigation includes the many efforts devoted to solving the problem of an economical extraction of the potash present in feldspar. Our supplies of the mineral are inexhaustible, and the potash content often ranges from 10 to 14 per cent. Thus far marked success has not attended the attempts in this field.

Some promising methods are emerging from the experimental stage, in which alumina is recovered simultaneously with potash. The utilization of feldspar in cement manufacture offers apparently the best chances of success under normal conditions. An essential feature is an ample supply of aluminiferous limestone to counter-balance the low percentage of alumina in feldspar.

Much more pronounced success has attended the efforts undertaken to economically utilize the nation's magnificent asset in the vast alunite deposits at Marysvale, Utah. The calcination process was first introduced in the autumn of 1915. Since then large amounts of potassium sulphate of a high technical quality have been regularly shipped to eastern points.

During 1916 the process based upon the use of nitric acid for the direct treatment of the rock has been introduced and shows itself to be an economic success. There is no evolution of acid fumes as in the calcination process. All of the potash present is obtained directly as potassium nitrate (saltpeter) of a high degree of purity. It can be employed directly in the manufacture of explosives and otherwise in the arts, or transformed into the many different potassium salts, for which there is so extended a demand, with a nearly complete recovery of nitric acid. The alumina present is likewise secured in a state of high purity, admirably adapted for use in the manufacture of metallic aluminum as well as in the manufacture of aluminum sulphate, the alums, etc.

---

*It is of interest in this connection to note that a large factory in California, which is using the process in question, has temporarily suspended its output of cement, on account of market conditions, but is still running its kilns in order to recover all available potash, and storing up the clinkers.

The process is a distinct contribution to our stock of technical operations in this field of chemical technology and seems destined to enable us easily to compete, under normal conditions, with Stassfurt as a source for the staple potash products required to such a vast extent in the arts. There is a possibility that in the cruder, least expensive forms, the saltpeter obtained primarily may play an important role in supplying a highly concentrated constituent of plant food for use in preparing artificial fertilizers to be transported long distances.

The recovery of potash salts from the highly concentrated brines or bitterns of various inland springs and lakes in the western section of the country is steadily attaining a notable degree of perfection. Shipments from Owens Lake and Searles Lake, California, have become a commercial factor. A large amount of capital has been invested at the latter point.

Another source of interest is the separation of potassium chloride from the mother liquors resultant from the extraction of salt from sea water on the California coast. The process gives every evidence of being a financial success.

Altogether those keenly following the evolution of a genuinely American potash industry have every reason to be satisfied with the giant strides made during 1916, in advancing rapidly toward the goal in view. Processes have reached such a state of perfection that the problem is now rapidly becoming one of a geographical nature, in which the rates of transportation between points of production and regions of consumption become dominant factors. The time requisite for the multiplication of factory units must also be taken into consideration.

The annual consumption of potash compounds in the United States, immediately prior to the world's war, was, as stated above, somewhat in excess of 1,000,000 short tons. The plant necessary for such an output will necessarily require several years in construction.

We can, however, look confidently forward to an early date in the future, when our American potash industry will be standardized, when the equilibrium between the varying costs of production in connection with the numerous sources mentioned above, and the miles of widely separated sections of our land, will be fairly well adjusted, when the fleet of steamers ordinarily transporting potash salts to our shore will be diverted to other purposes, and finally when American potash will seek an output in Latin America, across the Pacific and possibly even in Europe.

Of the "strangulation," the starvation, threatened by Professor Ostwald, there is not the slightest danger!

THE INDUSTRIAL CHEMIST AND THE FERTILIZER CRISIS.

By H. Clay Lint, Ph. D.*

Without Attempting to Disguise the Seriousness of the Situation Which This Country Will Be Called Upon to Face as Regards Nitrogen, Phosphorus and Potash for Fertilizers, the Author Herein Considers the Problem from the Standpoint of the Industrial Chemist, and Discusses Peat and Muck as a Source of Organic Ammoniates.

PERHAPS at no time in its comparatively brief history has the fertilizer industry been confronted with more serious problems. In seeking the reason for this situation by studying every item which helps to maintain the unstable commercial fertilizer equilibrium, we arrive at the same causative factor—war.

This industry draws the raw materials from which its finished products are prepared from all corners of the globe, and with practically all of these various corners embroiled in war, it is only natural that great difficulties should be encountered. Like the curing of any disease, whether personal or commercial, there exist but two methods of cure: the removal of the cause, or the finding of a remedy. In the present case, the removal of the cause is an impossibility, so that our efforts must necessarily focus upon remedial measures.

The chemistry of the fertilizer manufacturer includes but three elements; Nitrogen, Potash and Phosphorus. When the handling, however, reaches into the millions of tons, the small number of elements concerned assume a mien of greatest importance.

Thanks to wide newspaper comment, it is now common knowledge to the layman that practically all of our potash supply came from Germany. Chemists were quick to realize the necessity for prompt action in producing potash salts from domestic sources the moment overseas shipment from Germany ceased. To date, the chief sources of supply for domestic potash, according to the latest report of the United States Geological Survey, have been as follows:

---

*Research Chemist and Bacteriologist, Alphano Humus Co., 17 Battery Place, New York City.

Some Domestic Sources of Potash.

Mineral Sources: Natural Salts and Brines, 3,850 tons. Alunite and Silicate Rocks, including furnace dust recoveries, 1,900 tons; making a total derived from mineral substance of 5,750 tons. The data are for the 1916 output, which in value is ten times that of 1915, showing to what extent the production increased during the last year. Allowing for unreported sources, there were about 10,000 tons of K_2O produced, valued at $3,500,000.

From organic sources, 1,110 tons came from kelp. Twenty-three out of a total of seventy producers report a total tonnage of 220 derived from Wood Ashes. Miscellaneous industrial wastes contributed 1,750 tons, making a total from organic sources of 3,080 tons. The greater part of the mineral supply was obtained from the Nebraska alkali lakes. Late reports show that the large modern plant of the Pacific Coast Borax and the Solvay Process companies situated at Searles Lake in California are ready to start operation. The output from this place is estimated at 1,000 tons per month, which in itself practically equals the production of last year from all sources.

The most generous estimate for the 1917 production, however, does not measure up to the huge industrial and agricultural demand for potash, so that while an admirable start has been made, still the potash problem may be looked upon as unsolved.

A Nut for the Chemist to Crack.

The one big, almost inexhaustible supply of potash in this country lies in Orthoclase, or Potash Feldspar. To render this potash available, and at a cost that would make the process commercially profitable, is one of the problems that the industrial chemist has yet to solve. It is true that a great amount of work has been done, but none of the processes are above objection. It appears *a priori* that in some way this can be accomplished, and that orthoclase potash can be put on as big a commercial basis as the acid phosphate industry.

Industrial waste products can undoubtedly be made to yield a richer return in potash fertilizers as a result of improved methods to be worked out by the industrial chemist. Here again the limiting factor of costs is the shackle that must be broken in many instances. A better conservation and possible concentration of wood ash might easily make this source of supply of greater importance, but such work is more a matter of engineering than of chemistry. Converting the insoluble potash of wood ash into available form is a chemical phase of any wood ash work to be considered.

The close sighted layman sees no excuse for phosphorus shortage when told of our wonderful resources of this material. He fails to appreciate the vital importance of acidulation, and it is this chemical phase of production that has made the situation acute. The chief factor is that of interrupted commerce, and the traffic manager may be a more important person than the chemist as far as phosphoric acid is concerned.

Transportation Presents Serious Problem.

Coastwise traffic is greatly curtailed, due to the diverting of vessels to European channels. Rail transportation has necessarily increased to European channels. Car shortages all over the country have made the moving of materials most difficult. This is particularly so because of the present imperfect service of the Southern railroads, over which practically all phosphate rock must move.

A transportation factor that is influencing a more strictly chemical phase is that of a practical stoppage of the importation of Iron Pyrites from Spain.

This means that many of the big acid plants will be forced to remodel in order that they can use elemental sulphur. The enormous demand for sulphuric acid in the manufacture of munitions has practically doubled the cost of this article, so that we see a second legitimate reason why the cost of acid phosphate should be increased.

Raw rock phosphate has quite generally given less profitable results than those obtained from the acidulated material, and the difficulty cannot be eliminated by so happy a suggestion as the use of raw rock. Dr. Lipman, of the New Jersey Agricultural Experiment Station, has worked out a composting method, whereby sulphur, acidized by bacteria, forms sulphuric acid in the soil. By having this action take place in the presence of phosphate rock, the material is made available. About 60 per cent. to 75 per cent. of the total phosphorus is utilized

Considering the nitrogen conservation, the method recommends itself under many conditions. Many florists and truck gardeners annually prepare their compost piles, and where facilities are available, it is practical for farmers to add the proper amount of sulphur and floats to animal manure. Five parts of sulphur, fifteen parts of floats were added to one hundred parts of soil in the work reported by Lipman.

U. S. Must Face Nitrogen Situation.

The situation as regards nitrogen is fully as serious as that of potash. Imports of sulphate of ammonia and cyananid from Europe are practically cut off. Scarcity of ships for bringing nitrate of soda from Chili has greatly curtailed the importation of this material and forced a corresponding rise in the price. The fuller utilization of animal matteby the packers for foodstuffs has cut down on production, but the more serious aspect of the shortage has been brought about through the increased usage of organic ammoniates for animal feeding purposes. At present, any animal ammoniate is worth practically $5.00 a unit—with none on the market even at that price. Garbage tankage, which only a few years ago was considered greatly inferior, is now costing over $4.00 a unit, and the supply is short of the demand.

Great seriousness is attached to the organic ammoniate problem, because of the fact that the delectable status quo ante bellum will not be re-established by the treaty of peace. In fact, it can almost be stated that the day has passed altogether for the utilization of high grade animal tankages by the fertilizer industry.

Recently, many of the best chemical and biological minds have turned toward peat and muck as a source of supply.

Availability of Peat.

Peat exists in tremendous quantities in all quarters of the globe. It is rich in nitrogen and carries an abundance of organic matter, the presence of which is so essential to soil fertility.

When the absolute necessity of organic ammoniates is considered, together with the enormous quantities of muck material now conserved in the form of peat and muck, it would seem that Providence had expressly decreed this state of affairs.

Let us not infer, however, that all that is necessary is to dig raw peat or muck, use the same as animal or blood tankage, and obtain as beneficial results. Far from it, and it is this field that now opens up new opportunities to the industrial and biological chemist.

To fully understand the situation and its possibilities, it is necessary to consider the method of formation of these peat and muck deposits, and to consider this in the light of the function of decaying organic matter or humus in soils.

The normal cycle of organic matter calls for the synthesis of compounds by plants through the energy derived from the sun. After death, the products so formed are decomposed largely through the activity of micro-organisms, eventually becoming the same compounds from which the complex organic body was first formed.

But for the existence of unfavorable environmental factors, this same fate of complete decomposition or mineralization would have befallen the vegetable matter now conserved as peat and muck. Anaerobic conditions produced by the large quantity of water and organic acid formed by the decomposition are probably the chief agencies which have prohibited complete mineralization.

The problem of economic and beneficial utilization of the organic nitrogen of peat and muck concerns itself primarily therefore with the rectifying of conditions so that the cycle of decomposition, interrupted for ages because of adverse conditions, may again be renewed.

Problems of Peat Utilization.

Obviously the first essential is to remove the excess water through drainage. Secondly the acidity must be corrected. Of even greater importance however is the fact that a proper microbial flora must be introduced. Through all the years that the peat has laid under the unfavorable conditions, the original flora has been replaced by inferior species of micro-organisms. The beneficial types of decomposition are accomplished by more or less well defined microbial species, and these must again be introduced to complete their interrupted labors.

In England, thanks to wide newspaper comment, Bottomly has been able to show the benefits and results obtained from peat treated according to his especial prescription. In essence, his method consists of introducing a decomposing flora after having first rectified the acidity. Upon the completion of this process, the material is sterilized and a new flora, consisting largely of the independent nitrogen gatherers (Azotobacter sp.), is introduced. Making use of the organic substance first produced, these organisms fix additional nitrogen from the air. The product has been tried in only a small experimental way, and even though the process is entirely revolutionized in the light of further research, it marks a step in the right direction.

In this country, Mr. Hoff, of the Alphano Humus Company, was probably the first to appreciate the possibility of the utilization of such organic nitrogen. His method of preparation is much more comprehensive and concerns itself with the physical state of the material as well as the chemical and bacteriological.

Cultivation of the Deposit

The first step is naturally that of drainage and proper clearing of the deposit. Crops of onions, lettuce and celery, to which such formations are admirably adapted, are grown for from four to ten years. During this time heavy applications of lime, potash and phosphorus are made in order to thoroughly rectify conditions for the best microbial development as well as the higher plants.

The benefit brought about through cultivation is such that the mass is finely disintegrated, and upon drying it is much like dried blood from the physical standpoint. As prepared commercially by Mr. Hoff, the surface layers are removed by means of electric scrapers after thorough sun drying. The material is removed to a big compost pile containing from twenty to thirty thousand tons.

Just enough bacterial life exists to cause a mild heating without fire fanging, and the introduction of the proper types of bacterial life as well as proper chemical substance to favor that life was one of the biggest problems that confronted the industry. At present, a very satisfactory method of treatment has been worked out, but it still demands much study even after ten years of investigation. One trained in both chemistry and bacteriology is required for any type of investigational work in this field.

Introduction of Nitrifying Bacteria.

After composting, the material is passed through hot air driers and only enough moisture left to favor the persistence of the microbial population remains. A new flora consisting largely of the nitrifying bacteria, the independent nitrogen gatherers, (Azotobacter) and the symbiotic nitrogen gatherers (Radicicola) are then added, together with other chemicals which render the material more conducive to their development.

These organisms probably constitute the best type of beneficial flora and are present in numbers ranging from two to five hundred million per gram.

To what extent chemical fertilizers can be combined with such material without destroying the beneficial flora is an important problem to be solved in connection with the utilization of prepared humus as an ingredient of mixed fertilizers.

If we are to draw any lesson from the study of the past fertilizer history, it would point to peat and muck as the coming source of organic ammoniates. The use of animal tankage was at first ridiculed as rank folly, but gradually it has become the most highly prized fertilizer ingredient. Garbage tankage experienced the same ridicule, only to come to a position but little less esteemed.

Peat and muck nitrogen has had even more serious prejudice to overcome, but with diligent research and with the aid of proper bacterial and chemical treatment, this material will become just as highly valued. It is the one last source of organic ammonia that exists in large enough quantity and is at the same time cheap enough to make its use as a fertilizing material possible.

Because of the fact that this problem of organic nitrogenous fertilizer has come to stay and will not be alleviated with the termination of the war, it would seem that it offers one of the richest fields for investigation by the industrial bacteriologist and chemist.

POSSIBILITY OF THE RECOVERY OF POTASH FROM BANANA STALKS

In a communication to the "Journal of Industrial and Engineering Chemistry," H. E. Billings and A. W. Christie recall attention to the discovery made last year by Ellis, through an ash analysis of the banana stalk, of the surprisingly high percentage of potash in this material. The possible treatment of such material for the recovery of its potassium suggested to Billings and Christie a line of experimental work, the results of which they give in the communication above referred to. The following extracts from their paper indicate the great possibilities opened up by their experiments:

"The stalks were chopped into pieces about one-inch long and dried in the oven. The dried samples were exceedingly friable and easily broken or ground in a mortar. A sample was analyzed for fertilizing constituents with the following results:

	Per cent.
Total nitrogen (N)	0.44
Total phosphoric acid (P_2O_5)	0.42
Total potash (K_2O)	10.46
Water-soluble potash (K_2O)	7.72
Moisture	4.05

"The dry matter is as rich in potash as commercial kainit and may be considered nearly as valuable, since 74 per cent. of the potash is soluble in water. Were this material used as a fertilizer it is reasonable to assume that the organic matter would in time decompose in the soil with the formation of humus, resulting in the subsequent release of the remainder of the potash in an available condition. This material also approximates the composition and value of dried kelp, which at the present time is being used to a considerable extent as a filler in commercial fertilizers. In certain respects, the material under consideration is probably superior to kelp for this purpose. Especially to be noted is the fact that banana stalks contain only very slight amounts of sodium and chlorine whereas kelp contains such quantities as to throw it into the class of kainit or other chlorinated salts.

Weighed amounts of the dry matter were charred sufficiently to destroy organic matter and the resulting char leached with successive small portions of distilled water. About 16 per cent. of the dry matter was recovered in the form of water-soluble salts. A maximum yield was obtained with water representing five times the weight of original dry matter. The salts were dried to constant weight at 100 degrees C., and analyzed with the following results:

	Per cent.
Silica (SiO_2)	2.81
Iron oxide (Fe_2O_3)	None
Alumina (Al_2O_3)	None
Manganese oxide (Mn_3O_4)	None
Lime (CaO)	0.12
Magnesia (MgO)	0.07
Potash (K_2O)	64.23
Soda (Na_2O)	0.46
Sulfuric Acid (SO_3)	4.17
Carbonic acid (CO_2)	26.11
Chlorine (Cl)	1.57
Phosphoric acid (P_2O_5)	0.34
Total per cent	99.88

The above figures show that the leached salts consist of over 90 per cent. potassium carbonate.

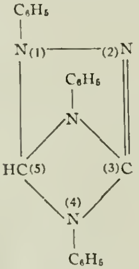
"NITRON"

As a Gravimetric Reagent for the Analysis of Substances Used in Explosives

By W. C. Cope and J. Barab*

The Object of This Paper Is to Collect the Rather Scattered Information Regarding "Nitron" and Its Applications, Add to It the Work Done in the Laboratory of the Pittsburgh Station of the Bureau of Mines, and Compile the Matter in a Comprehensive Form That Will Enable One Intelligently to Make a Hasty Survey of the Subject. This, It Is Hoped, Will Lead to Further Investigations and Result in the Use of "Nitron" for Many Analyses Which at Present Are Rather Involved.

"Nitron," discovered by Bausch[1] is the commercial name given to 1,4-diphenyl-3,5-endoanilodihydrotiriazol. Its formula is $C_{20}H_{16}N_4$ or



It is a basic substance forming salts with acids, a great number of which are practically insoluble in water. It is soluble in alcohol, benzene, chloroform, acetone, acetic acid, and acetic ether, slightly soluble in ether, and almost insoluble in water. Owing to its high molecular weight (312.2) it is particularly adapted as a gravimetric reagent for the compounds with which it forms practically insoluble salts. Busch[2] gives the solubilities of the following addition products, which "nitron" forms with acids: Bromide (1 in 800), iodide (1 in 20,000), nitrite (1 in 4,000), chromate (1 in 6,000), chlorate (1 in 4,000), perchlorate (1 in 50,000), nitrate (1 in 60,000). He[16] also states that "nitron" picrate is practically insoluble in water (1 in 250,000). Visser[13] claims that oxalic and salicylic acids also form insoluble precipitates. Sulphuric, hydrochloric, formic, acetic, boric, benzoic, tartaric, citric and phosphoric acids yield double salts. Visser has also applied "nitron" as a microscopic reagent for distinguishing many of its slightly soluble salts.

"Nitron," however, has found its most general application as a gravimetric reagent for nitric acid and its salts. Busch[8] recommends the use of "nitron" for the estimation of organic nitrates, and nitric esters. Utz[15] gives a method for the analysis of picric acid which is with slight modifications similar to that of Busch for nitrocellulose. Utz gives results for picric acid varying from 14.21% to 17.06% N as compared with the theoretical of 18.34% N. Because of the fact that his samples were not entirely water-free, definite conclusions cannot be drawn as to the accuracy of these determinations; for no standard is given with which to compare them. Since these were the only references that could be found regarding the application of "nitron" to nitric esters or nitro-compounds, these methods were investigated further to see how general their application could be made.

Effects of Other Substances.

Several investigators have experimented on the effects of other substances on this method of determination of nitrates. Paal and Ganghofer[23] found that dextrin, even if present to the extent of 2%, does not interfere with the complete precipitation of "nitron" nitrate, if enough time is allowed. Peptone interferes to some extent, but its influence may be overcome by adding a sufficiency of sulfuric acid. It may be removed from the solution by heating on the water bath for several hours, after adding formaldehyde, and the results of the "nitron" precipitation are then quite satisfactory. Gelatin if present to the extent of less than 0.5% does not interfere. It may be removed from the solution by the addition of tannin, the excess of which is then precipitated by means of normal lead acetate. A cold water extract of meat may be analyzed for nitrates after removing the interfering substances by the addition of normal lead acetate to the boiling solution; if alkaline, some acetic acid should be added. Hes[17] states that the presence of aluminum sulfate, magnesium sulfate, ammonium sulfate, potassium phosphate, magnesium chloride, tartaric acid, citric acid, sucrose and dextrose are without influence on the precipitation of "nitron" nitrate. When oxalic acid is present, the results obtained are too high. (Paal and Ganghofer, cited above, avoid the effect by the addition of H_2SO_4.) Chloric acid precipitates "nitron" quantitatively as "nitron" chlorate if the solution contains about 0.25% of chloric acid. Nitric acid and chloric acid may be determined together in the same solution if the amount of one of the acids is known. In this laboratory the effect of chloric acid is overcome by reduction with SO_2 or formaldehyde.[28] Adan[12], states that, if nitrites are present, the results obtained are high by an amount which does not correspond with the content of nitrite. Busch[7] analyzes a mixture of nitrites and nitrates, by first determining the nitrites by oxidation with permanganate and then precipitating the total nitrate in a separate portion as "nitron" nitrate after oxidation of the nitrite with hydrogen peroxide. Franzen and Löhman[18] comment on this method as follows:* "The usual volumetric methods for the estimation of a mixture of nitrous and nitric acids are inapplicable to bacteriological cultures; good results are obtained with "nitron." Busch's method is used, in which the total nitric acid is estimated after the nitrous acid has been oxidized to nitric acd by hydrogen peroxide, and the residual acid determined after the decomposition of the nitrous acid by hydrazine sulfate.

---

*From a contribution to the Journal of the American Chemical Society, Vol. XXXIX, No. 3, from the Explosives Chemical Laboratory, U. S. Bureau of Mines.

"The estimation in the presence of 'bouillon solution' gives too low results, owing to the retention of some 'nitron' nitrate in colloidal solution. If this is prevented by the addition of 2 to 2.5 cc. of concentrated H_2SO_4 per 200 cc. of solution, the estimation on the presence of 'bouillon solution' is as accurate as in water only. Since oxalic acid is a common constituent of bacteriological cultures, the presence of sulfuric acid has an additional advantage of preventing the precipitation of 'nitron' oxalate. A somewhat large excess of 'nitron' should be used."

Many modifications have been advocated for nitrate determinations by "nitron" by various investigators and indeed some have discarded this reagent because they were unable to get satisfactory results. "Nitron" has been used in this laboratory for several years, and some of the most accurate determinations of nitrates have been made with it. The method found most suitable for our work is very similar to the one proposed by Gutbier[3] and previously reported in one of this Bureau's publications.[26]

PREPARATION OF REAGENT.

To prepare the reagent one gram of "nitron" is dissolved in 10 cc. of 5% acetic acid (heating is unnecessary); the solution is filtered through an alundum crucible and placed in a dark bottle. The solution decomposes in the light and does not keep well, hence it is best to prepare it in small quantities as needed.

DETERMINATION OF NITRATES.

To the solution of nitrate, containing preferably not over 0.10 to 0.15 g. of nitrate, diluted to about 80 cc., add 12-15 drops of H_2SO_4 (2 acid to 3 water) heat to the boiling point, add 10-12 cc. of the "nitron" solution, stir, and let stand ½ to ¾ of an hour. Long, silky, needle-like crystals of "nitron" nitrate separate out on cooling. Place the breaker in ice water for 1½ hours and filter the crystals on a Munroe or Gooch crucible, using slight suction. Use part of the filtrate for washing out the beaker. Wash the precipitate with a total of 10 cc. of ice water, in 2 cc. portions and dry at 105° for one hour, which is usually sufficient to insure complete dryness. To confirm complete precipitation, heat the filtrate to boiling, add a little more of the reagent, and cool the mixture as before.

The molecular weight of "nitron" is 312.2, of "nitron" nitrate 375.2. Thus the nitrate being six times as heavy as HNO_3, an error in the weight of the precipitate is reduced to one-sixth when expressed as HNO_8, or to 1/27 when expressed as nitrogen.

SAPONIFICATION OF NITRIC ESTERS.

The nitric esters of importance used as explosives are the polynitrates of certain polyatomic alcohols. The polynitrates of glycerol, mannite, and in fact most of the common nitric esters have been branded with the misnomer of nitroglycerin, nitromannite, etc. Common practice sanctions the use of these misnomers and they are accordingly used in this paper.

When nitric esters are saponified they readily split off the nitrate groups. The alcohols, however, reduce the nitrate to nitrite* and probably under certain conditions are reduced as far as ammonia. To overcome the reducing action of the alcohols and at the same time to effect a complete conversion of all the nitrogen into nitric acid, it is necessary to use a strong oxidizing agent.

In the method worked out by Busch 3% hydrogen peroxide is used for this purpose. The procedure as given by Busch and used in this work may be briefly stated as follows:

About 0.2 g. of nitrocellulose is introduced into a 100 cc. Erlenmeyer flask, and 5 cc. of 30% aqueous caustic soda and 10 cc. of 3% hydrogen peroxide are added. The solution is heated on the water bath until frothing ceases, and then heated over a free flame to complete solution. 40 cc. of water and another 10 cc. of 3% hydrogen peroxide are then added and the liquid is heated to 50°. By means of a pipet 40 cc. of 5% sulfuric acid (sufficient to make the solution acid) are delivered at the bottom of the flask. The solution is heated just to boiling, and 12 cc. of the 10% "nitron" solution are added. From this point the process is exactly the same as for nitrates.

Results obtained in this laboratory by this method for nitric esters are given in the table on page 92.

As may be seen from the table, the determination by the nitron" method for nitrocellulose, nitromannite and nitrostarch, are quite satisfactory. The results for nitroglycerin, however, are not accurate enough for practical purposes. The figure 17.90% N was con-

---

*Taken from abstract, J. Chemical Soc. The English abstractors have made a curious error in referring to the "Bouillon Lösung" of the original as "Bouillon's Solution."

*Sidgwick in "Organic Chemistry of Nitrogen," page 9, makes the following statement in regard to nitroglycerin: "On (*b*) saponification (Robertson, *Chem. News*, 99, 289 (1909) the NO_3 groups are readily split off as nitric acid, but they oxidize the glycerol, and are themselves reduced to nitrous acid."

As there seemed some doubt as to whether metallic nitrates when once formed could be reduced to nitrous acid by the polyatomic alcohols, a simple direct experiment was made to determine this point. Three solutions were made up as follows:

1. Sodium nitrate, sodium hydroxide, glycerol, and water.
2. Sodium nitrate, sodium hydroxide, and water.
3. Sodium hydroxide, glycerol, and water.

Each solution was boiled for a few minutes, acidified with hydrochloric acid and tested with potassium-iodide starch test paper. The paper immersed in solution No. 1 was the only one which turned blue, the ones immersed in solutions Nos. 2 and 3 remained unchanged. The same experiment was tried with mannite in place of glycerol, with similar results.

This certainly leaves no doubt that certain alcohols will reduce sodium nitrate to sodium nitrite. From qualative tests it appears, however, that the alcohols will not reduce sodium nitrate after the metallic nitrate is once formed, to ammonia, but during saponification this probably occurs.

Determination of Nitrogen in Nitric Esters.

Substance	Per cent Nitrogen found by "nitron"	nitrometer
Nitrocellulose	13.13	13.15
	13.11	...
Nitromannite	18.24	18.33
	18.28	...
Nitrostarch	13.04	13.00
Nitroglycerin	17.90	18.40
	18.00	...

sistently obtained for many determinations of nitroglycerin. On investigating this matter further, it seemed evident that the glycerol resulting from saponification, exerted a much greater reducing action on sodium nitrate than most of the other alcohols liberated from nitric esters. For a number of determinations alcoholic caustic potash was tried, but owing to the further reducing effect of the added alcohol low results were again obtained. The method finally developed, which appeared to overcome these difficulties, was to use 30% aqueous caustic soda and 30% hydrogen peroxide. The method in detail follows:

Apparatus for Saponification.

The apparatus used for carrying out the saponification consisted of a 100 cc. Erlenmeyer flask with a ground glass air condenser 25 cm. long. A sample weighing 0.1000 g. is placed in the flask. A mixture of 5 cc. 30% NaHO and 5 cc. 30% H_2O_2 is added, and then about 15 drops of 30% H_2O_2 are introduced. The reflux condenser is attached and the apparatus placed in the water bath. After about 10 minutes, when the evolution of gas becomes very mild, 10-15 drops of 30% hydrogen peroxide are again added. This operation is repeated over a period of two hours, then twice at ½ hour intervals. By this time the small drop of nitroglycerin has disappeared from the surface, and further heating on the water bath will not accomplish any further saponification. About 8% of nitrogen is converted into nitric acid up to this point.

The reflux condenser is removed, 10-15 drops of 30% hydrogen peroxide added, a small Kjeldahl connecting bulb (to prevent splashing) is inserted into the Erlenmeyer by means of a rubber stopper, and the flask is heated for a few minutes over a free flame. The addition of H_2O_2 and heating is repeated twice and the solution is finally boiled down to a volume of about 3 cc. 40 cc. of water and 10 cc. of 3% H_2O_2 are added and the liquid is heated to 50°; the solution is acidified with 40 cc. of 5% sulfuric acid and the determination is completed in the same manner as for nitrocellulose. Results obtained for this method for nitroglycerin were 18.20, and 18.22% as compared with 18.40% obtained by the nitrometer.

Application to Nitrocompounds.

This method was then tried on several nitrocompounds, the results of which are given in the following table:

Substance	Per Cent N. Aqueous NaOH 30%	Alcoholic KOH 20%	Theoretical (total)
Tetranitromethylaniline	13.17	16.19	24.4
Tetranitroaniline	18.70	18.86	25.6
Trinitrotoluene	14.68	15.25	18.5

These results clearly show that the decomposition of nitrocompounds qualitatively into nitric acid cannot be readily obtained by this method.

The fact, however, that a large portion of the nitrogen of the nitro group is converted into the nitrate group indicates that it might be made quantitative by some variations of the method.

"Nitron" as an Aid in Differentiating Between Nitrates and Nitrocompounds.

In a recent article* we called attention to the fact that the nitrometer could not be used as a means of determining whether certain substances were nitrocompounds or organic nitrates. "Nitron" precipitates nitrates as "nitron" nitrate, while with nitrocompounds it either forms no precipitates, or one which is an addition compound of "nitron" with the nitrocompound, e.g., "nitrontrinitrocresolate." In the latter case the addition compound is readily distinguishable from the nitrate by the appearance of the precipitate. For specific examples urea nitrate, guanidine nitrate, nitrourea and nitroguanidine were investigated. Urea nitrate and guanidine nitrate both gave precipitates of "nitron" nitrate, but nitrourea and nitroguanidine gave no precipitate.

Urea nitrate gave 11.38 and 11.37 (theoretical 11.38%) N, and guanidine nitrate gave 11.16 and 11.21 (theoretical 11.46) N. The latter substance was not purified and the amounts found probably represent the true nitrogen content. "Nitron" therefore affords an additional means of differentiating between nitrates and nitrocompounds.

Determination of Picric Acid and Allied Substances.

As previously stated, picric acid forms a practically insoluble addition compound with "nitron." The following method was used for this determination:[16] 0.2000 g. of picric acid or its salt, is dissolved in 150 cc. water and 12-15 drops of 2:3 H_2SO_4 are added. The solution is heated to boiling and 10-12 cc. of 10% "nitron" solution are added. A bright yellow precipitate forms immediately, which is allowed to cool to room temperature for about two hours. It is unnecessary to cool these compounds in ice water. The precipitate is then filtered on a Munroe or Gooch crucible, dried for 1 hour at 105°, and weighed.

As trinitrocresol is very similar to picric acid in most of its reactions, a few determinations with "nitron" were made to ascertain whether this method is applicable to trinitrocresol and its salts.

---

*Jour. Am. Chem. Soc., 38, 2552 (1916).

PICRATE AND TRINITROCRESOLATE DETERMINATIONS.

Substance.	Wt. gram taken.	Cc. water required for solution.	Wt. subst. found.	Remarks.
Ammonium picrate........	0.2006	150	0.2007	C. P.
	0.2008	...	0.2008	
Trinitrocresol	0.1500	150	0.1502	Crystallized
	0.1500	...	0.1497	from alcohol
Ammonium trinitrocresolate.	0.1500	75	0.1465	
	0.1500	...	0.1470	Not purified

Phenol and the mono- and dinitrophenols were also tested in the above manner, but none gave a precipitate. 0.1000 g. 1,2,4-dinitrophenol dissolved in 200 cc. of water gave a copious yellow precipitate with "nitron" solution when no H_2SO_4 was added. This precipitate was filtered, washed, dried and weighed in the usual manner. Calculated on the basis of an addition product it gave 0.1009 g. dinitrophenol.

This immediately suggested a new method for the analysis of a mixture of picric acid and dinitrophenol. The following procedure was adopted:

0.1505 g. picric acid and 0.0500 g. dinitrophenol were dissolved in 250 cc. of water and heated to boiling without the addition of acid, and 12 cc. "nitron" solution were added. The mixture was cooled to room temperature for 2 hours, filtered, washed, dried at 105° for 1 hour, and weighed. This procedure was repeated on a similar sample, but with the exception that 15 drops 2:3 H_2SO_4 were added previous to boiling.

DETERMINATION OF A MIXTURE OF PICRIC ACID AND DINITROPHENOL.

	Weights taken.		Weights found.	
Conditions.	Picric acid.	Dinitrophenol.	Picric acid.	Dinitrophenol.
Acid added.....	0.1505	0.0500	0.1539	0.0000
No acid added...	0.1505	0.0500	0.1539	0.0466
	....	....	0.1505(*a*)	0.0495(*a*)

(*a*) Calculated.

The calculated results are given to show the almost complete insolubility of the mixed precipitates, and are obtained by deducting the theoretical weight of "nitron" picrate from the total precipitate.

Busch and Blume[15] give very good results for determining picric acid in this mixture when it is acidified with sulfuric acid. According to their results the calculated values in the table are what should be expected in these determinations. To our knowledge a more accurate method for this analysis is not known.

While this particular analysis may not be of very great importance, the method here suggested should prove a rather fertile field for investigation, especially as regards analyses of complicated mixtures.

Determination of Perchlorates.

A few determinations were carried out with commercial C. P. ammonium perchlorate by the same method as for nitrates. 0.12 g. of perchlorate was taken. Its purity by this method was found to be 99.67 and 99.58%, while by the fusion method, 99.53% purity was obtained. These results were previously recorded[26] and as far as known this was the first application recorded of "nitron" for the determination of perchlorates.

Determination of Oxide and Nitrogen.

C. G. Storm, former explosives chemist of the Bureau of Mines, in March, 1910, applied "nitron" to the analysis of a mixture of gas containing NO and NO_2. Later Burrell and Seibert[30] adopted his method for the determination of oxides of nitrogen in mine air. To our knowledge no other adaptation of the "nitron" method has been applied to gas analysis.

The method may be outlined as follows: By means of a separatory funnel, 10 cc. of a 5% solution of potassium hydroxide and 10 cc. of a 3% solution of hydrogen peroxide were poured into a 2-liter bottle; the hydrogen peroxide to oxidize the nitrous fumes to nitric acid, and the potassium hydroxide to form potassium nitrate. The bottles were shaken frequently to insure complete oxidation and absorption. The solution was then washed into a beaker, the wash being used sparingly so that the total volume of solution was not greater than 30-40 cc. The solution was then made slightly acid with 10% sulfuric acid, the solution heated to boiling and 10 cc. of "nitron" solution added. It was then cooled, filtered, and the precipitate was washed, dried and weighed in the usual manner. Theoretically 1 cc. of nitric oxide requires 0.01344 g. of "nitron," and 1 cc. of nitric oxide is equivalent to 0.0168 g. of "nitron" nitrate.

RESULTS OF GAS ANALYSIS WITH THE "NITRON" METHOD.

Sample No.	No. present, cc.	No. found, cc.	Sample No.	No. present, cc.	No. found, cc.
1..........	3.7	3.5	6..........	0.2	0.2
2..........	2.4	2.4	7..........	0.2	0.2
3..........	2.8	2.6	8..........	0.8	0.6
4..........	0.9	0.6	9..........	1.7	1.5
5..........	2.7	2.5			

Results obtained by Burrell and Seibert on measured amounts of nitric oxide, prepared in a Lunge nitrometer from pure nitrates, are given in the preceding table.

They comment on these results as follows:

> "It is shown from the above results that with a sufficiently large sample of mine air (5 or 10 liters) quantities of nitric oxide much below that required to produce harmful effects on men can be detected by this method."

When a mixture of NO and NO_2 are present the NO may be determined by absorption in $FeSO_4$ solution and the difference will be NO_2.

Recovery of Reagent.

"Nitron" varies in price from four to six dollars per ounce, and as its recovery is a simple matter, it is usually worth while to save the "nitron" precipitates and filtrates.

The filtrate and washings are made slightly alkaline with ammonia and the precipitated "nitron" filtered and washed with water. The "nitron" precipitates, along with the asbestos mats collected from the crucibles used in the determinations, are added to dilute ammonia solution and warmed to 60°. The precipitated "nitron" with asbestos is quickly filtered under slight suction and washed with cold water. The mass is then digested in 5% acetic acid until the "nitron" has dissolved, and again filtered. The filtrate is then made slightly alkaline with ammonia and the "nitron" filtered off. It is then washed with cold water and dried in a vacuum. Decomposition may be avoided by conducting the filtering and washing in an atmosphere of inert gas and as much as possible away from light.

Conclusions.

1. The methods employed and the results obtained

in this paper by the use of "nitron" clearly show its advantages in the following respects, over other general methods employed for the determination of nitrogen in substances containing it, such as the Dumas, Kjeldahl, and nitrometer methods:

(*a*) Manipulation is simpler.

(*b*) Less time is required.

(*c*) The necessary apparatus is simple and inexpensive.

(*d*) No special skill is required for following directions and obtaining good results.

2. Heretofore "nitron" was used directly as a precipitant in the analysis of nitric acid, perchloric acid, picric acid and their salts. Its use has been extended directly as a precipitant to the analysis of trinitrocresol and its salts, and to mixtures of picric acid and dinitrophenol.

3. "Nitron" has previously been employed to precipitate the nitrate formed on saponification of nitrocellulose. The value of this method has been confirmed in this paper, and the same method is extended for the analyses of the nitric esters of mannite and starch.

4. The failure of the saponification method as applied to nitrocellulose is shown in the case of nitroglycerin, and a modification of the method is developed which is applicable to nitroglycerin.

5. The addition compounds of "nitron" with picric acid and trinitrocresol are shown to be the most insoluble compounds which the trinitrophenols form.

6. The analysis of a mixture of dinitrophenol and picric acid by the use of nitron is the simplest method known for such mixtures.

7. By treating true nitro compounds with a solution of alkaline peroxide it is not possible to convert quantitatively the NO_2 group to the NO_3 group.

FACTORS FOR NITRON DETERMINATIONS.

Substances.	Addition product formed.	Factor for N.	Factor-substance sought.
Nitric acid	Nitron nitrate	0.03734	0.16797
NO	Nitron nitrate	0.03734	0.07989
NO_2	Nitron nitrate	0.03734	0.12263
Potassium nitrate	Nitron nitrate	0.03734	0.26946
Sodium nitrate	Nitron nitrate	0.03734	0.22657
Ammonium nitrate	Nitron nitrate	0.03734	0.21335
Guanidine nitrate	Nitron nitrate	0.03734	0.32540
Urea nitrate	Nitron nitrate	0.03734	0.32802
Nitrocellulose	Nitron nitrate	0.03734	(*)
Nitromannite	Nitron nitrate	0.03734	(*)
Nitrostarch	Nitron nitrate	0.03734	(*)
Nitroglycerin	Nitron nitrate	0.03734	(*)
Picric acid	Nitron picrate	0.07765	0.07765
Ammonium picrate	Nitron picrate	0.07765	0.07765
Trinitro cresol	Nitron trinitrocresolate	0.07569	0.43774
Ammonium trinitrocresolate	Nitron trinitrocresolate	0.07569	0.46843
Dinitrophenol	Nitron trinitrophenolate	0.5645	0.37087
Ammonium perchlorate	Nitron perchlorate	.....	0.28471
Potassium perchlorate	Nitron perchlorate	.....	0.33577
Sodium perchlorate	Nitron perchlorate	.....	0.29676

*The factors percentage of purity, of course, depend on the state of nitration

BIBLIOGRAPHY OF LITERATURE ON "NITRON"

1. "Endo-imino-triazoles," I. Max Busch, *Ber.*, 38, 856-860 (1905); *J. Chem. Soc.*, 88, I, 307 (1905).

2. "Gravimetric Estimation of Nitric Acid," Max Busch, *Ber.*, 38, 861-866 (1905); *J. Chem. Soc.*, 88, 282 (1905).

3 "Gravimetric Estimation of Nitric Acid by Means of Nitron," Alexander Gutbier, *Z. angew. Chem.*, 18, 494-499 (1905); *J. Chem. Soc.*, 88, II, 418 (1905).

4. "Estimation of Nitric Acid in Water," Max Busch, *Z. Nahr.-Genussm.*, 9, 464-468 (1905); *J. Chem. Soc.*, 88, II, 418 (1905).

5. "Estimation of Mixtures of Sulfuric and Nitric Acids," G. Lunge and E. Berl, *Z. angew. Chem.*, 18, 1681-1687 (1905); *J. Chem. Soc.*, 90, II, 49 (1906).

6. "Endo-imino-triazoles," II. Max Busch and Gustave Mehrtens, *Ber.*, 38, 4049-4068 (1905); *J. Chem. Soc.*, 90, I, 115 (1906).

7. "Oxidation of Nitrous Acid by Hydrogen Peroxide. Estimation of Nitrates in the Presence of Nitrites," Max Busch, *Ber.*, 39, 1401-1403 (1906); *J. Chem. Soc.*, 90, II, 392 (1906).

8. "Estimation of Nitrogen in Nitrocellulose," Max Busch, *Z. angew. Chem.*, 19, 1329 (1906); *J. Chem. Soc.*, 90, II, 708 (1906).

9. "Gravimetric Estimation Potassium Nitrate in Meats," Carl Paal and Gustav Mehrtens, *Z. Nahr.-Genussm.*, 12, 410-416 (1906); *J. Chem. Soc.*, 90, II, 898 (1906).

10. "Triazoles," Max Busch, *J. prakt. Chem.*, 74, II, 533-549 (1906); *J. Chem Soc.*, 92, I, 259 (1907).

11. "The Nitron Method for the Estimation of Nitric Acid," Stanley W. Collins, *Analyst*, 32, 349-357 (1907); *J. Chem. Soc.*, 92, II, 349 (1907).

12. "Estimation of Nitrates by Busch's Method," R. Adan, *Bull. soc. chim. belg.*, 21, 229-233 (1907); *J. Chem. Soc.*, 92, II, 651 (1907).

13. "Nitron as a Micro Chemical Reagent," H. L. Visser. *Chem. Zentr.*, 1907, I, 302; *Chem. Weekblad*, 3, 743-746 (1906); *J. Chem. Soc.*, 92, II, 394 (1907).

14. "Employment of Nitron for Determining Nitrates in Soils and Plants," Jacob Litzendorff, *Z. angew. Chem.*, 20, II, 2209-2231 (1907); *J. Chem. Soc.*, 94, II, 130 (1908).

15. "A New Method for the Evaluation of Picric Acid," Staff Apothecary Utz, *Z. anal. Chem.*, 47, 140-144 (1908); *C. A.*, 2, 1670 (1908).

16. "Estimation of Picric Acid," Max Busch and G. Blume, *Z. angew. Chem.*, 21, 354-356 (1908); *J. Chem. Soc.*, 94, II, 328 (1908).

17. "Gravimetric Estimation of Nitric Acid," A. Hes, *Z. anal. Chem.*, 48, 81-98 (1909); *J. Chem. Soc.*, 96, II, 265 (1909).

18. "Estimation of Nitric Acid by Nitron in Liquids Containing Many Organic Substances," Hartwig Franzen and E. Löhman, *J. prakt. Chem.*, 79, II, 330-338 (1909); *J. Chem. Soc.*, 96, II, 517 (1909).

19. "Gravimetric Estimation of Nitric Acid," Max Busch, *Z. anal. Chem.*, 48, 368-370 (1909); *J. Chem. Soc.*, 96, II, 615 (1909).

20. "Busch's 'Nitron' Process," Peter Booth, *Z. anal. Chem.*, 48, 375-376 (1909); *J. Chem. Soc.*, 96, II, 615 (1909).

21. "Estimation of Nitric Acid with 'Nitron,'" Carl Paal and August Ganghöfer, *Z. anal. Chem.*, 48, 545-555 (1909); *J. Chem. Soc.*, 96, II, 759 (1909).

22. "Application of Busch's 'Nitron' Method to the Analysis of Chili Saltpeter," Leopold Radlberger,

Chem. Zentr., 1910, II, 685-686; from *Oesterr. ung. Z. Zuckerind.*, 39, 433-436 (1910); *J. Chem. Soc.*, 100, II, 69 (1911); *C. A.*, 5, 1721 (1911).

23. "Estimation of Potassium Nitrate in Meats by Means of 'Nitron,'" Carl Paal and A. Ganghöfer, *Z. Nahr.-Genussm.*, 19, 322-328 (1910); *J. Chem. Soc.*, 94, II, 453 (1910).
24. "Use of Nitron in the Analysis of Nitrates," Alex. M. Vasilieff, *J. Russ. Phys. Chem. Soc.*, 42, 567 (1910); *J. Chem. Soc.*, 98, II, 1109 (1910).
25. "The Accuracy of Nitrate Estimation," Siegfried Seydel and L. Wichers, *Z. angew. Chem.*, 43, 2046-2054 (1911); *J. Chem. Soc.*, 100, II, 1132 (1911).
26. "Analysis of Permissible Explosives," C. G. Storm, Bureau of Mines, *Bull.* 96. "Determination of Perchlorates by 'Nitron,'" p. 65. "Recovery of 'Nitron,'" p. 62. "Solubility of Nitron Nitrate," p. 61.
27. "The Determination of Nitrogen in Substances Used in Explosives," W. C. Cope and Guy B. Taylor, Bureau of Mines, *Tech. Paper* 160.
28. "Die Explosivstoffe," R. Escales, 6, 351 (1915).
29. "Chemisch-technische Untersuchungs Methoden," G. Lunge and E. Berl, Bd. 1, p. 391 (1910).
30. "The Sampling and Examination of Mine Gases and Natural Gas," George A. Burrell and Frank M. Seibert, Bureau of Mines, *Bull.* 42.

ULTRA VIOLET LIGHT.

Its Application in Chemical Arts.

By Carleton Ellis and A. A. Wells.*

This Is the Third Installment of an Article Dealing with Investigations Conducted by the Writers Into the Possible Applications of Ultra Violet Light, and the Results Obtained Following the Exposure of Various Elements and Compounds to the Action of Its Rays. The Present Installment Continues a Discussion of the Work of Other Investigators. Part IV Will Appear in the Next Issue.

PART III

FURTHER NOTES ON HALOGEN COMPOUNDS AND HALOGENATION.

According to the process of *Tompkins* (British Patent 780, Jan. 18, 1915; J.S.C.I., 1915, 1225) coal-gas, rich in ethane, is produced by distilling coal at a low temperature e.g., 500-600° C. The *ethane*, together with a little *ethylene*, is separated by liquefaction, then again converted into gas, mixed with a suitable quantity of chlorine, and chlorinated by exposure to actinic light from a quartz lamp. The hydrogen chloride produced in the reaction is absorbed in water and used to prepare a solution of a chloride, e.g., zinc chloride, from oxide or carbonate, the solution being afterward electrolyzed to produce chlorine for use in a subsequent chlorination process. The coal-gas may also be chlorinated direct, in which case the actinic power of the light must be kept below that which would cause appreciable chlorination of the methane present.

Brooks, Essex and Smith (U. S. patent 1,191,916, July 18, 1916) describe a process of chlorinating liquid hydrocarbons, such as *gasoline*, and *petroleum oils, benzol, toluol, etc.*, in which a temperature-controlled body of such liquid hydrocarbon is treated with chlorine under the influence of actinic light. The chlorine is introduced at a point in the liquid body remote from that at which the rays of actinic light enter, as by illuminating a body of liquid hydrocarbon from the top while introducing chlorine gas at the bottom. For example, gasoline, or a fraction obtained by distilling gasoline, is placed in an opaque vessel having means for controllable illumination at one end, a mercury vapor lamp, or a nitrogen filled tungsten lamp, provided with a rheostat, being used. At the bottom of the container an inlet is provided for introducing gaseous chlorine. Means are also provided for agitating the liquid. As the light shines through the liquid it causes reaction of chlorine and the hydrocarbon. If the liquid is not circulated, the upwardly diffusing chlorine and the downwardly passing light soon establish a zone of maximum reaction somewhere between the top and the bottom. If the liquid be circulated, the action is somewhat different, since circulation will bring a greater or less amount of chlorine containing liquid under the influence of the light rays. In so doing the concentration of the dissolved chlorine in the liquid in the illuminated zone is always small, there always being a large excess of hydrocarbon over chlorine in the zone where action is taking place. This is stated to conduce to smoothness of reaction in forming monochlor derivatives. With artificial circulation the reaction is more uniform Chlorine, dissolving in the oil, colors it yellow and as the chlorine disappears from solution by reaction with the liquid, the color of the liquid is discharged. The active light rays pass through the uncolored oil, but not through the colored. Hence the less the amount of dissolved chlorine, the better the penetration of the light rays. The reaction chamber is provided with a heating and cooling coil and a reflux condenser is used when the operation is carried on with heating. Means are provided for removing and collecting the hydrochloric acid formed. In making mixed *butyl, pentyl, hexyl*, etc., *chlorides* for the manufacture of artificial "amyl acetate" the chamber is filled with a liquid gasoline fraction, distilling between 25° and 45°C., and chlorine is introduced into the liquid in minute bubbles. As these pass upward they are dissolved to a greater or less extent. The liquid becomes charged with chlorine from below upward, the most concentrated solution being at the lowest point. The chlorine solution is brought upwardly toward the light by agitation. The intensity of the actinic rays passing downwardly is diminished in proportion to the amount of chlorine in the solution and to the depth of the solution through which they pass. The amount of light therefore penetrating to the lower layers of gasoline containing greater amounts of chlorine is diminished to a degree permitting only a gentle action.

---

*All rights of publication in book form reserved by the authors, Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

The maximum action of the light and of the chlorine takes place in a zone in which the gasoline is in large excess and the tendency of the action of the light is therefore merely to make the monochlor products; and not to induce further chlorination of mono compounds already produced. The chlorination is carried to a point where about 20 per cent. of the material is converted into mono-chlorides when the operation is interrupted and the unchanged oil is separated from the chlorides by fractional distillation. If dichlorides are to be produced, the process is the same, save that in lieu of charging the container with hydrocarbon, it is charged with mono-chlorides. If the material to be chlorinated is not a liquid, it may be melted or dissolved, as by using carbon tetrachloride. For example, paraffin may be melted and chlorinated by this process.

A process of *Brooks* and *Padgett* (U. S. patent 1,220,821, March 27, 1917) involves the production of non-volatile *unsaturated hydrocarbons* from *petroleum* oils, in which the use of ultra violet light is suggested. The product is stated to be suitable as a non-saponifiable substitute for linseed oil in paint compounds. For example, solar oil, is chlorinated in accordance with the reaction:

$$C_{15}\ H_{32} + 2Cl_2 \longrightarrow C_{15}\ H_{30}\ Cl_2 + 2HCl$$

thereby also obtaining hydrochloric acid as a by-product.

The dichloride thus obtained is then subjected to a high temperature, ranging from 350° C. to 550° C. in the presence of a catalyst when hydrochloric acid is split off with the formation of unsaturated hydrocarbon. The final product is found to have an iodine number varying from 120 to 150 according to the boiling point of the solar oil and is capable of absorbing oxygen with the formation of a "drying" film, such as is given by linseed oil.

Ellis (U. S. patent 1,202,040, Oct. 24, 1916) describes a process for the manufacture of *benzyl chloride* from toluol by the continuous circulation of toluol through an apparatus in which an excess of toluol vapor is produced and acted upon by chlorine at an elevated temperature to promote side chain chlorination, under gradually increasing temperature conditions and in the presence of actinic light to promote the chlorination. The benzyl chloride is then condensed and removed and the remaining vaporous material subsequently condensed and the hydrochloric acid substantially eliminated before the remaining toluol is returned to the still for retreatment. The chlorine may be preheated before coming into contact with the toluol vapor. The treating chamber may be heated by an air heater or heating jacket. The treating chamber is subjected to the influence of actinic light after the reaction has been largely completed, mercury lights being arranged around the treating chamber adjacent to its discharge end. Quartz glass is used to permit full actinic effect. Catalyzing material may be added to the toluol, phosphorus pentachloride being used to advantage. The preliminary portions of the chamber may also be filled with fragments of pumice, porcelain, etc., these materials considerably promoting the reaction. The treated vapors leaving the chamber contain benzyl chloride, hydrochloric acid gas, and unchanged toluol vapor. The toluol is converted to the extent of a quarter or a half during each passage. These mixed vapors are passed through a dephlegmator to collect the benzyl chloride. The remaining vapor passes from the dephlegmator into a condenser where the toluol is condensed and flows back into the still. The hydrochloric acid gas is eliminated by a separating chamber from which the gas is allowed to discharge. Additional toluol is continuously supplied to the system.

Ellis has also described (U. S. patent 1,146,142, July 13, 1915) a special form of chamber for chlorinating toluol through the agency of ultra violet light. Side chain chlorination is effected, producing *benzyl chloride, benzal chloride* and *benzotrichloride*.

According to *Ransford* (British patent 16,317, July 8, 1914; J.S.C.I. 1915, 1203) tetrachlorotoluene is obtained by passing dry chlorine into toluene in the presence of iron or anhydrous iron chloride at 12-15°C., the mixture being agitated. When trichlorotoluene crystallizes out, the mass is melted by heating to 45-50°, then cooled to 35°C., and chlorine again introduced, gradually increasing the temperature to 50°C., until the necessary increase in weight has occurred. Only traces of pentachlorotoluene should be shown by precipitation on dilution of a sample with an equal volume of carbon bisulphide. On fractional distillation a yield of 90% of the theoretical quantity of tetrachlorotoluene is obtained. Further chlorination at 100-130°C. in presence of light, particularly ultra violet rays, gives *tetrachlorbenzal chloride*.

In *brominating hydrocarbons* or effecting other reactions promoted by a mercury vapor light, *Keyes* (U. S. patent 1,198,356; Chem. Abs. 1916, 2815) proposes that one of the reacting substances, e.g., bromine, be fed from a flask, into a quartz vessel, provided with a mercury vapor lamp, made integral with the flash and having a stirrer, a condenser and inlets and outlets. In another form of apparatus for similar use a vacuum jacket is interposed between an annular reaction chamber and a mercury lamp, to prevent deleterious heating of the reacting substances by the lamp.

The action of light on *iodine* and on *starch iodide* in water has been studied by *Bordier* (Compt. rend. 163, 205-6, 1916; Chem. Abs. 1916, 2669). To one litre of water were added ten drops of 10% alcoholic solution of iodine, to the same volume containing a little fresh starch paste were added three drops of 10% iodine. Both suspensions were decolorized when exposed to light for a few hours, while similar suspensions not exposed retained their color. Yellow glass did not prevent or retard the action. Bordier suggests that the violet or ultra violet rays remove the charges from the colloidal particles of iodine and starch iodide, and the iodine then combines with the hydrogen ion from the water to form hydriodic acid. After decolorization both suspensions showed acid reaction.

The influence of light on the gaseous systems *hydroiodic acid, hydrobromic acid, hypochloric acid,* and their components has been investigated by *Cohen* and *Stuckardt* (Z. physik. Chem. 91; 722-44, 1916; Chem. Abs. 1917, 749) from both sides of the equilibrium, at room temperature. The experiments have been carried out in quartz glass, uviol glass, and Jena glass, which permitted the determinations of the photochemical equilibrium in three different spectral regions. The percentage decomposition of the acid when equilibrium is attained is given below:

	In quartz glass.	In uviol glass.	In Jena glass.
Acid.	220 u.	254 u.	300 m.
Hydriodic	92.2%	100%	100%
Hydrobromic	100%	about 20%	0%
Hydrochloric	0.42%	0%	0%

The absorption of the halogen acids and the halogens in the ultra violet has been studied, and it has been found that it depends upon the thickness of the absorbing layer. Various conclusions regarding the position of the photochemical equilibrium in the different spectral regions are drawn from a consideration of the course of the absorption curves with increasing thickness of the absorbing layer.

Olivier (Rec. Trav. Chem. Pays Bas, 1916, 36, 117-125; J.S.C.I. 1916, 1149) states that when *para chlorbenzene sulphochloride* in ethereal solution is exposed to direct sunlight or the rays of a "uviol" lamp, chlorine is liberated and oxidation takes place with the formation of the free sulphonic acid. When the experiment is carried out by passing dry oxygen through the ethereal solution of the sulphochloride while exposed to the rays of the lamp, the quantity of chlorine collected shows a deficit as compared with the equivalent of sulphonic acid formed, and aldehyde and hydrochloric acid are found in the aqueous liquid on treatment with water. It is probable, therefore, that some of the chlorine reacts with the ether to form chlorethyl ether, which is subsequently hydrolyzed to aldehyde. Under favorable conditions, the decomposition of the sulphochloride under the influence of light and oxygen may amount to over 40% in six hours, and the reaction is practically inhibited in the absence of light or oxygen. The presence or absence of moisture has no appreciable influence. The photo-chemical decomposition of the sulphochloride is considerable in ethereal solution but only slight in chloroform solution. In benzene and carbon tetrachloride, the reaction does not take place. It is suggested that the formation of a peroxide may play a part in the reaction. Other sulphochlorides of the benzene series behave in a similar manner but to a lesser degree.

DIFFERENT EFFECTS OF ULTRA VIOLET LIGHT ON ORGANIC COMPOUNDS.

In an article on the effect of light on organic compounds *Gerretsen* (Chem. Weekblad 13, 220-32, 1916) states that the action depends on wave length; ultra violet light tends toward decomposition, while longer wave lengths are more apt to cause polymerization and condensation. In general, light favors endothermic reactions. The decomposition of *carbon dioxide* into carbon monoxide and oxygen caused at ordinary temperatures by ultra violet light, is proof of the powerful dissociating action of light. This effect is important in the photochemical synthesis of carbohydrates. *Hydrocarbons* in ultra violet light generally polymerize; e.g., *acetylene* yields *benzene* and a resinous substance. *Alcohols, aldehydes* and *ketones* decompose into carbon monoxide, hydrogen and hydrocarbons. Ethers decompose like alcohols, but yield less hydrogen and more hydrocarbon. *Acids* yield carbon dioxide and a hydrocarbon, with some carbon monoxide and hydrogen, probably due to preliminary reduction to aldehyde. *Dibasic acids* readily lose carbon dioxide, leaving the monobasic acid. *Keto acids* react the same with ultra violet light as with heat. *Esters* yield carbon monoxide, carbon dioxide, hydrogen and a hydrocarbon. *Sugars* react very much as with ferments. *Bioses* yield monoses; *trioses* a monose and a biose, which then yields two monoses. *Monoses* break up into carbon monoxide, methane and hydrogen. Some relation is to be expected between the absorption spectrum of a substance and its photochemical activity. According to *Henri* and *Wurmser*, the latter depends solely on that part of the absorption spectrum coinciding with the atomic groups affected by photochemical action. The rest of the light energy absorbed appears as heat. This gives the possibility that photochemical decomposition may differ with different wave lengths, depending on the groups responsible for absorption. Thus Bielecki and Henri were able to break up the absorption curves of *aldehydes* and *ketones* into simple elementary curves. Aldehydes gave two and ketones three curves. They conclude that rays of different wave lengths are absorbed by different groups.

Photochemical oxidations and reductions are either equilibriums affected by light, or complete decompositions. The temperature coefficient is always low. The solvent has some influence; thus, chloroform, benzene, carbon tetrachloride, or ethyl acetate solution is oxidized by ultra violet light to chlorine, carbon monoxide and water, but not in carbon disulphide, ethyl ether, ethyl alcohol or acetone solution. Many substances such as mercury chloride, iron chloride, iron nitrate, uranyl salts, oxides of iron, manganese and cobalt, etc., act as catalyzers of photochemical oxidations. The reaction $CH_3OH + KNO_2 = HC(OH):NOK + H_2O$ proceeds only in the light. Formaldehyde can be used instead of methyl alcohol. Further action of light gives substances containing a pyrrole or pyrrolidine ring, possibly identical with nicotine. This may give an insight into the synthesis of nitrogen compounds by plants. Intramolecular photochemical oxidations and reductions are quite common.

Photochemical polymerization, condensation and isomerization occurs in many cases. *Sugars* can be formed from formaldehyde in ultra violet light; but this hardly explains the presence of carbohydrates in plants, since sun light has very little effective ultra violet light. *Ketones* and *aldehydes* are especially susceptible to photochemical condensation. Many photochemical isomerizations are equilibriums which can be changed by changing the wave length. Those which reverse in the dark, Marckwald calls photoropic. In general, rays of high wave length change the labile to the stable form; ultra violet rays have the opposite effect. Photochemical hydrolysis is also very common; thus, most *esters* are saponified by water under the influence of light. The field of organic photochemistry, aside from its general significance, is very important in the study of structure.

EFFECT OF MOISTURE ON THE DECOMPOSITION OF CARBON DIOXIDE.

The action of ultra violet light on *carbon dioxide* has been determined at various pressures by *Coehn* and *Sieper* (Z. physik. Chem. 347-81, 1916; J. Chem. Soc. 110, 281-2; Chem. Abs. 1916, 2549). It is shown that an unchangeable stationary condition is set up with the time on exposing carbon dioxide to ultra violet light. The wave-length of the active light lies below 254. The decomposition is modified with increasing pressure more than is demanded by the law of mass action, as is also the case in the photochemical decomposition of water vapor. The decomposition is inversely proportional to the pressure. The photochemical decomposition of carbon dioxide is very sensitive to traces of water vapor, but in the opposite sense to all other photochemical reactions. For example, in the case where a dry gas is decomposed to the extent of 18%, the merest trace of moisture reduced the amount of decomposition to 0.1%. It is shown that neither formic acid nor formaldehyde is formed, and that the water undergoes no change. On the other hand it is shown that on illuminating a mixture of equal volumes of carbon dioxide and hydrogen with ultra violet light, *formaldehyde* is produced.

It is also found that *ozone* is stable in ultra violet light at 240°. Coehn and Sieper are unable to reproduce the results of Chapman in which it is shown that the presence of carbon monoxide increases the amount of ozone produced when oxygen is submitted to ultra violet light. Carbon dioxide is also shown by them to have no effect on the amount of ozone produced.

In the photochemical decomposition of *hydrogen peroxide* in dilute aqueous solution, Tian (J. Chem. Soc., 1915, 108, ii., 828-830; J.S.C.I., 1916, 114; Chem. Abs. 1916, 1960) finds the velocity increases with the increasing frequency of the exciting radiation, and when thin layers of solutions of varying concentration are exposed to the light emitted by a quartz-mercury arc lamp, the velocity is proportional to the intensity of the incident radiation and not to the absorbed luminous energy. This result is attributed to the heterogeneity of the radiation and the fact that rays of different wave-length are not absorbed in a constant ratio. The temperature-coefficient for the interval 10°-30°C. is 1.15. The velocity is slightly diminished by the addition of small quantities of acids and very considerably increased in the presence of traces of alkali. The reaction between hydrogen peroxide and ozone is accelerated by the action of ultra violet radiation. Whereas ultra violet rays of moderately short wave length (2500-3000) are able to bring about the decomposition of hydrogen peroxide at a measurable rate, pure water is only decomposed by rays in the extreme ultra violet. If the water contains dissolved oxygen, this reacts with the hydrogen set free in the primary photochemical decomposition of the water, and thus indirectly increases the rate of formation of hydrogen peroxide in that the velocity of the reversed reaction $H_2O_2 + 2H = 2H_2O$ is thereby diminished. At the same time, the dissolved *oxygen* is to some extent transformed into *ozone* under the influence of the ultra violet rays, and the ozone formed reacts with the hydrogen peroxide. Special experiments have shown that ozone has no action on water under these conditions. Conditions favorable to the formation of hydrogen peroxide are obtained (1) by the use of a source of ultra violet light which is rich in rays of very short wave-length; (2) by exposing the water to the action of the light in thin layers; (3) by eliminating as far as possible the factors which tend to bring about the decomposition of the hydrogen peroxide. This decomposition may be diminished by the use of pure water and of ultra violet radiation from which the rays of moderate wave-length have been cut off. The disturbing influence of ozone may be eliminated to a large extent by passing a current of air through the solution. The radiation from high-tension quartz mercury lamps which have been in use for some time is not nearly so rich in short-wave rays as the light which is emitted by new lamps of this type or that which is obtained from low-tension lamps.

The rays of the quartz mercury lamp according to *Gibbs* (J. Am. Chem. Soc 1912, 1193) color pure *phenol*, in the presence of oxygen, with remarkable rapidity. Samples exposed in small dishes covered with quartz plates are colored light red after an exposure of one minute.

UNION OF ACETYLENE AND METHANE.

According to a process described by *Heinemann* (U. S. Patents, 1,202,385, Oct. 24, 1916, and 1,134,667, April 6, 1915) the union of *acetylene* and *methane* is effected by heating these gases in the presence of catalytic metals, such as iron, nickel, copper, silver, platinum, iridium and palladium. Instead of using heat, the union of the acetylene and methane in the presence of catalytic metals is effected through the agency of ultra violet or other chemically active rays. For example, pumice stone, provided with a coating of copper, is dipped in a solution of chloride of platinum, and is dried. The salt is then reduced. In this way there is obtained a contact body consisting of two metals which are stated to exert a mutual balancing effect on one another, the more active property of the platinum group metal being mitigated by the less active property of the other metal associated therewith, and allowing the desired reaction to take place at a moderate temperature. A mixture of equal volumes of acetylene and methane is passed into a reaction tube containing the catalyst. During the passage of the mixture through the tube the reaction space is subjected to the influence of chemically active rays. When ultra violet rays are used a number of mercury lamps are supported in close proximity to the reaction tube.

BEER YEAST.

According to *de Fazi* (Ann. chim. applicata 4, 301-29, 1915; Chem. Abs. 1916, 950) the action of ultra violet rays is favorable to *alcoholic fermentation* for a relatively long time, (12 hours). *Beer yeast,* exposed to ultra violet rays for a definite time, increases in activity, and is not killed by the rays even after 14 hours' exposure. It is possible to select beer yeast by the action of ultra violet rays. The experiments were carried out in quartz flasks placed about 20 centimeters from a mercury lamp used as the source of the rays. A resume is given of previous work done on this subject.

EPINEPHRINE.

Epinephrine solutions were subjected by *Savapol* (Compt. rend. soc. biol. 77, 458-9, 1914; Chem. Abs. 1917, 489) to the action of ultra violet rays (by a method described by Parisot, Poeper and Crouzon) in order to determine if the action of epinephrine on erythrocytes is thereby modified. 1 c.c. of a 5:100 emulsion of sheep erythrocytes in 9:1000 sodium chloride solution was introduced into each of a series of test tubes all of which contained 1 c.c. of varying dilutions of epinephrine solutions which had been irradiated for periods of 10 min., 1½ hrs. and 3 hrs. The mixtures were kept at 37° for periods of 10-30 min.; control tubes contained non-irradiated epinephrine solutions. Agglutinations of erythrocytes without hemolysis was observed in tubes which contained epinephrine in the dilution of 1:5000. Hemolysis was produced with increasing intensity of greater concentrations (1:4000, 1:3000, 1:2000; 1:1000); the non-hemolyzed erythrocytes remained strongly agglutinated. Irradiation by ultra violet rays did not cause diminution of the hemolytic and agglutinating properties of epinephrine; on the contrary the agglutinating action was intensified to a certain extent, being produced more rapidly and completely. Corpuscle permeability was the same in the case of both normal and irradiated epinephrine.

According to Savopol (Compt. rend. soc. biol. 77, 460-1, 1914; Chem. Abs. 1917, 490), *Maric* has shown that a mixture of *epinephrine* and *tetanus toxin* can be rendered non-toxic by heating at 37 for 20 hrs.; Savopol has attempted to ascertain whether this neutralizing property of epinephrine on tetanus toxin is modified by irradiation of epinephrine by ultra violet rays. The technic previously adopted was employed. The periods of irradiation were 10 min., 1½ hrs. and 3 hrs. After determining the minimum lethal dose of tetanus toxin, (which was 0.001 c.c.) each of a series of white mice was injected with 1 c.c. of a mixture of epinephrine and tetanus toxin which had been kept at 37 for 20 hrs. Epinephrine lost its neutralizing action on tetanus toxin after a sufficiently prolonged period (3 hrs.) of exposure to ultra violet rays. An exposure of 10 minutes was sufficient appreciably to weaken this property without completely destroying it.

Savopol (Compt. rend. soc. biol. 77, 459-60, 1914; Chem. Abs. 1917, 89) states that *epinephrine hydrochloride* subcutaneously injected in 1:1000 solution in guinea pigs, causes local necrosis, and he attempted to determine whether epinephrine subjected to irradiation by ultra violet rays preserves this necrotizing property. A 1:1000 solution of Takamine epinephrine was placed in vacuo in a quartz vessel which was rotated rapidly (in order to prevent overheating and to equalize irradiation), the periods of exposure (to a mercury quartz lamp) being 10 min., 1½ hrs. and 3 hrs. The epinephrine thus irradiated was at once subcutaneously injected in guinea pigs. Necrotizing power was not modified by 10 minutes irradiation. This property disappeared completely, however, after 1½ hrs. irradiation, no more than a local inflammatory reaction being produced at the spot of subcutaneous inoculation.

MERCURIC CHLORIDE.

The action of ultra violet rays on *mercuric chloride* solution and on some *mercury salts* has been studied by *Pougnet* (Compt. rend. 161, 348-51, 1915; Chem. Abs. 1916, 863). A solution containing one gram mercuric chloride in 20 cubic centimeters of water, enclosed in quartz, was exposed at 15 centimeters to a mercury arc lamp. Mercuric chloride formed at once. The unreduced mercuric chloride found after 10 minutes was 0.831 grams; after 20 minutes 0.676 grams; 30 minutes 0.582 grams; 50 minutes 0.552 grams; 70 minutes 0.528 grams; 90 minutes 0.524 grams. Mercuric chloride suspended in water is slowly changed to mercurous chloride and mercury, the reaction becoming more rapid with time. Qualitative observations are appended on a number of salts of mercury dry and moist, under the rays. Most are darkened more or less; a few are unaltered.

PHOTOELECTRIC SENSIBILITY.

A Dolezalek electrometer was used by *Krüger* and *Taege* (Z. Elektrochem. 562-9, 1916; Chem. Abs. 1916, 720) to measure the photoelectric sensibility of *platinum* plates to light from a quartz mercury lamp, a special apparatus being used. The photoelectric sensibility was decreased by typical catalyzer poisons such as carbon monoxide, hydrocyanic acid and hydrogen sulphide, especially the last. After poisoning with hydrogen sulphide, the photoelectric sensibility was not wholly restored after repeated admission of air and evacuation again. Perhaps a film of platinum sulphide was formed, as has been assumed in other cases of poison. In the other cases the photoelectric sensibility was rapidly restored and there was a kind of exaltation, as is usual in such cases, and which is in agreement with the smallness of the effect in high vacuum. A part of the effect may be due to penetration of the gases into the metal film which makes it difficult to get reproducible results. Bombardment of the platinum with nitrogen was without effect, showing the electrochemical indifference of this element. Bombardment with carbon dioxide caused a small increase in the photoelectric sensibility; ammonia caused no increase. It appears that the easy emission of electrons (which corresponds to a high photoelectric sensibility) is closely connected with some catalytic process which cannot be explained without further knowledge of the catalytic process itself.

(To be continued in the June issue.)

ACCURATE SILICA DETERMINATION IN COMMERCIAL ANALYSIS

By

F. G. Hawley*

This Paper Is a Discussion of Methods of Silica Analysis, with Notes on the Errors Introduced by a Variation on the Amount, Strength and Temperature of Acid Used in Preliminary Reduction, and Length of Time Under Treatment. The High Cost of Platinum Has Led to the Introduction of a Method Employing Nickel Crucibles, Which Is Here Described In Detail.

Theoretically, the determination of "true" silica is a simple process, but it is found in commercial analysis that it is frequently a difficult matter to get satisfactory results. With careful work a chemist can usually get duplicate determinations to check within 0.3 to 0.4%, but frequently different chemists will not agree to within 2%. In view of these facts it would seem that chemists should investigate the cause of the errors and adopt some procedure that would at least tend to minimize these divergencies.

In "Bulletin 422" of the United States Geological Survey—"The Analysis of Silicate and Carbonate Rocks"—Dr. Hillebrand describes how an accurate SiO_2 determination can be made, but the method given is not suitable to commercial work where speed is necessary. Dr. Hillebrand and others proved long ago that there were three main sources of error in the method commonly used: A plus error from the small amount of SiO_2 from the flux; another plus error due to impurities retained by the SiO_2; and a minus error due to the solubility of the SiO_2 in the HCl.

In my experience the amount of SiO_2 introduced with the flux usually amounts to less than 1 mg. and a satisfactory correction may be easily made if the flux is measured. The amount of impurity retained by the SiO_2 may vary according to the elements present and to differences in the acid treatment, but generally amounts to between 0.1 and 0.3%. By far the largest and most troublesome error is the one due to the solubility of the SiO_2 in the HCl. This error is much greater than most chemists realize. I have known of several who carefully deducted 0.3 to 0.4% for SiO_2 from the flux and impurities in the SiO_2, but failed to add anything for the SiO_2 lost in solution, which in these instances was about 1.7%.

Dissolving of SiO_2 in HCl.

According to my observations the amount of freshly precipitated SiO_2 that dissolves in HCl, depends on the following conditions: First, the amount of acid present; second, the strength of the acid; third, the temperature; and fourth, the length of time the silica is in contact with the acid. There may be other conditions governing the solubility of SiO_2 in HCl, but these seem to be the principal ones. By far the most important is the amount of acid used.

Most chemists use acid of about the same strength to treat the dehydrated silica, and the assays are brought to a boil, insuring the same temperature, and are boiled for a fairly uniform length of time. Few, however, consider the importance of using a definite amount of acid. It seems to be a prevalent idea that the amount of silica dissolved by the acid solution is proportional to the amount of SiO_2 in the sample. When a small bulk of acid is used, this is certainly not the case. The experiments shown in Table 1 prove clearly that when a small amount of SiO_2 is present, the amount dissolved is proportional to the quantity of acid solution present and not to the amount of SiO_2 in the sample. These experiments were made on the standard sample of argillaceous limestone issued by the Bureau of Standards, which contains, according to the analysis made by Dr. Hillebrand and Dr. Waters, 18.15% of SiO_2.

---

*Chief Chemist, International Smelting Co., P. O. Box 351, Miami, Ariz. From Engineering and Mining Journal.

One-half gram samples were fused in platinum dishes with sodium carbonate dehydrated at 140° C., and run in the ordinary way except that varying amounts of 60% HCl were used. All were boiled five minutes, filtered, and the filtrate evaporated a second time to recover the SiO_2 dissolved.

Solubility of SiO_2 in HCl with Varying Amounts of Acids.

TABLE I.

No.	HCl Used, C.C.	SiO_2 on Filter, %	SiO_2 from Filtrate, %	Impurity in SiO_2 %
1	10	17.90	0.28	0.12
2	20	17.78	0.48	0.10
3	30	17.58	0.60	0.10
4	50	17.02	1.16	0.12
5	70	16.52	1.60	0.08
6	100	16.12	2.04	0.08

This experiment has been repeated many times by different chemists and always with similar results. Some text-books recommend using 50 to 100 c.c. of dilute HCl to dissolve the bases, but do not intimate that as much as 2% of SiO_2 may be dissolved from a sample that contains less than 20%, as shown in Table I.

Much light is thrown on this subject by the following experiment, in which different weights of an ore containing 70.8% SiO_2 were assayed in the usual way. The samples were all boiled two minutes with 10 c.c. of 60% HCl. The other conditions were the same except for the varying amounts of ore.

Solubility of SiO_2 in HCl with Varying Amounts of Ore

TABLE II.

No.	Sample Weight, Gram	Calculated SiO_2 in Sample, Gram	SiO_2 on Filter, Gram	SiO_2 from Filtrate, Gram
1	0.5	0.3540	0.3528	0.0014
2	0.5	0.3540	0.3516	0.0016
3	0.2	0.1416	0.1405	0.0015
4	0.1	0.0708	0.0696	0.0015
5	0.05	0.0354	0.0342	0.0013
6	0.02	0.0142	0.0136	0.0010
7	0.01	0.0071	0.0070	0.0008

This experiment has also been repeated several times with similar results and proves that the amount of SiO_2 that goes into the filtrate is almost constant and in no way proportional to the amount contained in the sample. This does not hold entirely true with samples containing less than 30 to 40 mg. of SiO_2 or when excessive amounts of acid are used.

The fact that nearly the same amount of SiO_2 is lost in the filtrate from a sample containing 10% as from one containing 70% naturally leads one to inquire why it does not all dissolve when present in very small amounts, or how SiO_2 that has once gone into the filtrate can be recovered by a second evaporation. The following seems to be at least a partial explanation: When the solution containing silica is evaporated, it precipitates as small flakes. As soon as the hot acid is added, these begin to dissolve very slowly. In samples containing 10% SiO_2 or more, the relatively large number of flakes, presenting a correspondingly large surface to the action of the acid, will quickly saturate it; consequently no more can dissolve from a high-grade sample, than from one containing about 15%. On the other hand, when the sample contains but little silica, there will be but few flakes and the rate of solubility of these will not be sufficiently rapid to saturate hte solution in the ordinary time taken for a determination. From this it must follow that when very small amounts of SiO_2 are to be determined, the acid solution should not be boiled longer than necessary.

To prove that the length of boiling has an influence on the results the experiments referred to in Table III were made, 0.5 gram of ore containing 24.1% of SiO_2 being used in each case.

Effect of Variation in Time of Boiling

TABLE III.

No.	25% HCl C.C.	Boiled, Min.	SiO_2 on Filter, Gram	SiO_2 from Filtrate, Gram
1	70	1	0.1146	0.0050
2	70	2	0.1138	0.0054
3	70	4	0.1130	0.0068
4	70	10	0.1120	0.0090
5	70	20	0.1117	0.0092
6	15	1	0.1182	0.0020
7	15	2	0.1186	0.0020
8	15	5	0.1188	0.0018
9	15	12	0.1194	0.0016

These experiments demonstrated that when there is considerable volume of acid solution, some time is needed to saturate it, and consequently the length of boiling time is of considerable importance. On the other hand, with only a small amount of acid solution it very quickly becomes saturated and so the length of time it is boiled is of less consequence. If boiled long enough, the solution may concentrate to such an extent that the dissolved SiO_2 will begin to reprecipitate. This is indicated in the last two experiments shown in Table III.

Table IV gives the results of experiments made to see what effect a variation in the strength of HCl would have on solubility. The results were rather surprising, as it was found that HCl of 15 to 25% strength would dissolve much more SiO_2 than stronger acid.

In each experiment 75 c.c. of acid was used and boiling was continued for five minutes.

Effect of Variation in Strength of HCl

TABLE IV.

No.	HCl %	SiO_2 on Filter, Gram	SiO_2 from Filtrate, Gram
1	80	0.1199	0.0030
2	40	0.1142	0.0064
3	25	0.1110	0.0095
4	15	0.1112	0.0095
5	8	0.1140	0.0060
6	4	0.1160	0.0054
7	1	.....	0.0038
8	0.5	.....	0.0022

The SiO_2 from experiments 7 and 8 was too badly contaminated with iron to weigh. From other experiments it was found that pure water has a very slight solvent action on SiO_2, which is greatly increased by the presence of NaCl. Considerable NaCl is always present from the action of HCl on the flux, and part of the solubility is undoubtedly due to this cause.

In a further series of tests (Table V) hot acid proved to be more effective in dissolving SiO_2 than cold. Stirring also affected the result. In these experiment 70 c.c. of 40% HCl was in contact with the SiO_2 for 10 min.

Samples 3 and 4 were placed in a water bath containing boiling water and heated as hot as possible.

From the results of this and the previous series of experiments it can readily be seen that adding boiling water to dilute the assay or washing the sides of the casserole should be avoided, as it would be equivalent to using a large volume of hot dilute acid, which would result in an excessive loss. Tests made to determine the most satisfactory temperature and length of time for dehydrating the SiO_2 indicate that heating to 120° to 150° C. for 30 min. gives satisfactory results. If heated to a higher temperature or for a much longer time, the solubility is slightly decreased but the silica will be contaminated by more impurities. Ordinarily, I find that boiling for three minutes with 15 c.c. of 60% HCl will give about as pure silica as could be obtained by boiling longer or with more or stronger acid.

EFFECT OF TEMPERATURE OF SOLUTION

TABLE V.

	Temperature	SiO_2 on Filter, Gram	SiO_2 from Filtrate, Gram
1..........	Boiled	0.1148	0.0068
2..........	Boiled	0.1146	0.0066
3..........	88°C stirred	0.1164	0.0048
4..........	88°C not stirred	0.1176	0.0040
5..........	70°C stirred	0.1176	0.0038
6..........	70°C not stirred	0.1186	0.0028
7..........	45°C stirred	0.1186	0.0022
8..........	45°C not stirred	0.1194	0.0020

A source of error not generally known is caused by the silica adhering to the casserole so tenaciously that it is not removed by ordinary rubbing. When the acidified solution is evaporated quite slowly to dryness, the silica has little tendency to stick to the casserole; but if the solution is evaporated rapidly, and especially if it is boiled, considerable silica sticks to the casserole and can only be partly rubbed off. The silica adheres mostly to the side at or near the surface of the liquid and forms a roughened ring. When first used, very little silica adheres to the casserole, but with each repeated usage the ring becomes larger and rougher and accumulates more. To reduce this error to a minimum the casserole should be kept as smooth as possible. To remedy the roughening, which is frequently mistaken for etching of the glaze, watch the casserole and as soon as a slight roughening is noticed, remove it carefully with dilute hydrofluoric acid. Place a spoonful of water in the casserole and then an equal amount of HF and quickly rub with a rubber finger cap or "policeman." As soon as no rough places can be felt, quickly empty out the acid and rinse well If these operations are carefully done, the glaze is not injured noticeably.

When making SiO_2 determinations on sulphide ores or ores containing much Cu, Pb, Sb or other easily reduced metal that would attack the platinum crucible, it is customary to give the sample a preliminary acid treatment to remove the objectionable metal and then determine SiO_2 on the insoluble residue. The necessity of this acid treatment, together with the high cost of platinum, led to the introduction a few years ago of a new method, using nickel crucibles and a flux of $Na_2O_2 + NaOH$, and eliminating the acid treatment.

This method is used extensively at a number of the large copper camps of the West. Several years ago I made an extensive series of tests to see how its accuracy would compare with the standard sodium-carbonate method. Many experiments were made on analyzed samples issued by the Bureau of Standards, and many comparative assays were also run by the two methods on regular work. These tests, which were carefully made, proved that with careful manipulation the new method is capable of giving as good results as the longer sodium-carbonate method. Most of the foregoing experiments were run by both methods.

The sodium hydroxide used in the new method reacts with the silica of the ore, forming sodium silicate and water. This water is in the form of steam, and if the fusion is started too hot the escaping steam may cause a slight mechanical loss. This will not happen if care is taken to start the fusion at a very low temperature and to increase the heat slowly.

In either method, after dissolving the melt and acidifying, the flux is changed to NaCl, and as the operations are the same from this point onwards and as the same salts are present in about the same quantity, there can be no difference due to the method.

My own modification of the peroxide method, as used for routine work, is as follows: Weigh 0.5 gram of pulp into a 30 c.c. nickel crucible and add one scoopful (about 4 grams) of flux composed of equal parts of sodium peroxide and sodium hydroxide. Mix the pulp and flux, and if the sample is known to contain over 50% of SiO_2 put on a cover to prevent loss. Fuse at a low temperature beginning much below redness and increasing very slowly until a dull red is reached. A good way to make the fusion is to set the crucibles in an iron tray having holes punched to accommodate them and constructed so that they are held about half an inch above the floor of the muffle. Introduce the tray with crucibles into the muffle at a low red temperature and fuse for three or four minutes.

The Life of Nickel Crucibles.

When the fusions are made as described the nickel crucibles can be used from 20 to 40 times, but if the temperature is too high, or if there is too much sodium peroxide in the flux, they will burn out much quicker.

Remove the crucibles and partly cool; place in 4-in. casseroles, and cover the crucibles with 2-in. watch glasses so placed that a slight opening is left on one side. Through this opening squirt in 2 or 3 c.c. of warm distilled water from a wash bottle. This should start a vigorous reaction between the water and the flux. As soon as the action has somewhat diminished add 3 or 4 c.c. more water and continue to do this until the fused mass is disintegrated. Toward the end the water should be added with enough force to thoroughly stir the contents. If the crucible gets too cold or the water is not hot enough, the action may cease before the melt is loosened from the crucible; and if too hot the contents may boil over. With a little practice the right conditions are readily found. As soon as the action ceases and the crucible is a little over half full, rinse off the watch glass and from a large burette add about 10 c.c. of 60% HCl in small portions so as to avoid too violent reaction; then add 90% HCl until it is in excess. The crucible should now be about full and everything in solution except possibly a little gelatinous silica.

With the fingers or platinum-tipped tongs, remove the crucible, rinse, and place the casserole on the hot plate to evaporate. No harm is done if it boils gently at first. When about half evaporated, place the casserole on an iron or aluminum ring so made that the bottom of the casserole is kept about one-quarter inch above the hot plate. These rings are very beneficial in preventing spitting. When the residue has become dry, cover with a watch glass and bake at about 135° C. for 30 min.; remove and when cool add 15 c.c. of 60% HCl and turn about so as to moisten all parts of the residue. Allow to stand a short time and then put on the hot plate, and with cover still on, boil for 3 min. Remove and allow to cool, rinse the sides down with the minimum amount of warm distilled water, and swirl around to loosen any crust still adhering to the sides. The NaCl does not all dissolve, but will readily do so in the wash water.

It is very necessary that the casserole should not be heated after rinsing down the sides with water. After standing a few minutes, transfer the contents to a filter and wash twice with warm water; then once with hot dilute HCl and add a little to the casserole. Rub the sides and bottom of the casserole to loosen any adhering SiO_2 and rinse into the filter. This SiO_2 is ground rather fine by the rubbing and has a tendency to clog the filter, hence it is better to add this after the main portion has been partly washed. Wash the filter twice again with water, place in a crucible, partly dry, and ignite strongly for ten minutes. Weigh the SiO_2 as soon as cool, for it is hygroscopic. A correction is now made for the SiO_2 lost in solution, which under these conditions will amount to about 0.4%. A deduction is made for impurities in the SiO_2 and the SiO_2 from the flux. These gains about balance the solubility loss. Occasional tests should be made to check losses and gains.

It is evident from the nature of the flux that some special method for preparing and storing it will be necessary. The following has proved satisfactory: Take a half-pound or more of pure dry NaOH and grind up, a few sticks at a time, in an iron mortar so that the largest pieces are no larger than a grain of wheat. The grinding must be done quickly, or the NaOH will absorb moisture. Place it in a wide-mouthed jar and add an equal amount of Na_2O_2 and mix by rotating. A satisfactory jar to use is a small 4-in. straight-sided desiccator with a circular piece of gasket rubber for a cover. The jar should be opened as seldom as possible, but in spite of this precaution the flux will slowly absorb moisture. This moisture reacts with the sodium peroxide, changing it to hydroxide, probably according to the following equation:

$$Na_2O_2 + H_2O = 2NaOH + O$$

From this it will be seen that the H_2O is chemically held and so the flux will still be dry, but the oxidizing power is lost. When such flux is used, the fusions will fail to disintegrate properly when hot water is added. The remedy is to add more Na_2O_2 from time to time.

DEVELOPMENT OF SODA DEPOSIT IN EAST AFRICA

In a communication to the U. S. Bureau of Foreign and Domestic Commerce, Consul Henry P. Starrett at Mombasa, British East Africa, states:

A large deposit of raw crystalline soda at Lake Magadi, situated in the southern part of this protectorate, near the frontier of German East Africa, has attracted attention in recent years. This lake has an area of approximately 324 square miles and contains from 50,000,000 to 200,000,000 tons of sesquicarbonate of soda. On account of the existing soda springs in the lake, the supply is constantly being renewed, and it may therefore be said to be nearly inexhaustible. The raw material must be reduced to soda ash. Analysis of the product shows: Soda crystals, 98.55 per cent; salt, 0.20 per cent; sulphate of soda, 0.110 per cent; moisture and traces of impurities, 1.15 per cent.

About five years ago the Magadi Soda Co. (Ltd.), a British corporation, was formed to take over a 99-year lease of this deposit, with the company under the management of M. Samuel & Co., of London. In 1913 a branch railway line was constructed to connect the property with the Uganda Railway system, thus affording an outlet for shipments at the seaport of Kilindini.

May Resume Active Operations.

In 1914 the company expected to ship about 80,000 tons and gradually to increase the annual output until it reached 200,000 tons. Just at the time their plans were beginning to materialize, however, the war put a stop to operations. It is believed that active operations will be resumed just as soon as ocean freight rates become normal, or the market price of the product advances to a point which will warrant the payment of the present high shipping charges. The company has been granted a very favorable railway rate from the mines to the seacoast, enabling it to place the product aboard ship at Kilindini for about $4 per long ton. The ocean rate from Mombasa to New York via Durban or Liverpool is now about $39 per long ton (2,240 pounds).

[The London address of this company may be obtained from the Bureau of Foreign and Domestic Commerce, its district or cooperative offices. Refer to file No. 85677. Articles relating to the enterprise were published in Daily Consular and Trade Reports for March 9 and June 27, 1911, and September 26, 1913.]

MANUFACTURING TESTS OF COTTON FUMIGATED WITH HYDROCYANIC-ACID GAS

By

William S. Dean*

The Results of the Tests Described in the Following Paper Indicate That the Fumigation of Cotton with Hydrocyanic-Acid Gas Does Not Affect to Any Material Extent the Percentages of Waste, Spinning Qualities, Tensile Strength, Bleaching, Dyeing, or Mercerizing Properties of the Cotton.

INTRODUCTION.

The spinning tests herein described were suggested by a joint committee of cotton manufacturers and officials of the Federal Horticultural Board, who met and discussed plans of preventing the introduction into the United States of the pink boll worm[1] with the importations of foreign-grown cotton. As hydrocyanic-acid gas had been found by that Board to be a practicable and successful fumigating agent[2] in the destruction of these pests, even though the larvæ were in the center of a compressed bale of cotton, it was decided that manufacturing tests should be made to determine whether the fumigation by this agent would cause an injury to the cotton fibres.

SPINNING TESTS.

The manufacturing tests were conducted by the United States Department of Agriculture, under the direct supervision of the Office of Markets and Rural Organization. Through the courtesy of the president and manager the tests were made at the New Bedford Textile School, New Bedford, Mass., on two separate lots of cotton, a portion of each lot having been fumigated with hydrocyanic-acid gas under the supervision of the Federal Horticultural Board. In each lot the fumigated cotton was compared with nonfumigated cotton of the same lot.

The principal points taken into consideration during the spinning tests to determine whether the fibers were injured by the fumigation were (1) the percentage of waste, (2) the spinning qualities, (3) the tensile strength of the yarn. During the laboratory tests the following points were considered: (4) The bleaching properties of both the cotton and yarn, (5) the dyeing properties of the cotton and yarn, and (6) the mercerizing properties of the yarn.

In addition to the manufacturing tests, made by the Department of Agriculture, a number of manufacturing firms that regularly use foreign-grown cotton conducted tests in order to ascertain whether the fumigation of cotton with hydrocyanic-acid gas proved detrimental to their product. These tests were conducted in cooperation with officials of the Department of Agriculture.

Several manufacturing companies also sent yarns to Washington which were tested in the yarn testing laboratory of the Department of Agriculture for tensile strength. Two of these firms sent complete reports which included the comparative waste percentages of fumigated and nonfumigated cotton as found by them.

Stock of Cotton.

In the tests conducted by the Department of Agriculture the first lot consisted of two 50-pound samples, one taken from a fumigated bale and one from a nonfumigated bale. Both bales were of Sakellaridis Egyptian cotton 1¼ inch in length of staple. The fumigated bale was fumigated with hydrocyanic-acid gas on at least five dfferent occasions in a vacuum of 27 inches. The amount of sodium cyanide employed varied from 3 to 10 ounces per 100 cubic feet of chamber space with exposures ranging from thirty minutes to one hour. The volume of gas which penetrated this bale was fully ten times as much as that ordinarily used in accordance with the regulations prescribed by the Federal Horticultural Board. All other fumigated cotton referred to in this publication was exposed to hydrocyanic-acid gas in the presence of a 20-inch vacuum with 3 ounces of sodium cyanide per 100 cubic feet of chamber space with an exposure of one-half hour. The second lot consisted of 50-pound samples from each of six bales of Sakellaridis Egyptian cotton of 1½ inches in length of staple.

Three of the bales were fumigated and three bales were nonfumigated. In the selection of the fumigated and nonfumigated cotton a careful comparison was made of grade and staple in order to secure equal values.

A few samples of fumigated and nonfumigated Peruvian and Chinese cottons were secured from the mills and chemical laboratory tests were made on these cottons in the department of chemistry and dyeing of the New Bedford Textile School.

---

*Assistant in Cotton Testing, U. S. Department of Agriculture. From a Bulletin Issued by the Department.

[1] Hunter, W. D., The Pink Boll Worm. Unnumbered publication U. S. Department of Agriculture, Bureau of Entomology, August, 1914.

[2] For a description of this method of fumigation see U. S. Department of Agriculture, Federal Horticultural Board. Service and regulatory announcement No. 21, 1915.

Methods of Comparison.

Each bale was given a mark so that it could not readily be identified while in the manufacturing processes as to whether it had been fumigated. The fumigated and nonfumigated cottons of each lot were opened and left standing overnight. They were run through the machines under the same conditions of speeds and settings, and where possible the fumigated and nonfumigated portions of each lot were placed side by side on the same machine, advancing together through the various processes of manufacture. Between each run the machines were cleaned thoroughly. Total weights were taken before and after the cotton was fed into the opener, finisher, cards and combers respectively. Records of humidity were taken hourly and the humidifiers regulated accordingly, keeping the relative humidity as nearly uniform as possible for the respective lots.

Waste Percentages.

Table I gives the comparative waste percentages of the fumigated and nonfumigated cotton.

Lots No. 1 and No. 2 represent the 1¼-inch staple and the 1½-inch staple, fumigated and nonfumigated cotton given separately, which were tested at the New Bedford Textile School, New Bedford, Mass. Lots No. 3 and No. 4 represent a digest of the reports received from the two manufacturing firms.

TABLE I.—*Waste percentages.*

[Based on net weight of cotton fed into each machine.]

Kind of waste.	Lot No. 1.		Lot No. 2		Lot No. 3.		Lot No. 4.	
	Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated.
Opener:								
Visible—								
Dust room	0.67	0.25	0.46	0.33	....	....	....	....
Motes and fly	1.06	1.50	.87	.67	....	....	1.45	1.47
Total visible	1.73	1.75	1.33	1.00	0.65	.53	1.45	1.47
Invisible	2.53	1.75	.29	.62	.83	.55	.05	.03
Total visible and invisible	4.26	3.50	1.62	1.62	1.48	1.08	1.50	1.50
Finisher:								
Visible—								
Dust room	.14	.14	.09	.09	....	....	....	....
Motes and fly	1.43	.96	.74	.05	....	....	.47	.48
Total visible	1.57	1.10	.83	.74	.78	.63	.47	.48
Invisible	.14	.13	.18	.04	1.15	.61	.03	.03
Total visible and invisible	1.43	1.23	1.01	78	1.93	1.21	.50	.51

The figures given in Table I are based on the net weight of stock fed into each machine. It will be observed that there is no decided indication of the superiority of either the fumigated or nonfumigated cotton. The percentages of waste fluctuate considerably, without being consistently in favor of either the fumigated or the nonfumigated stock. Similar differences would be expected to exist in the comparisons of any two bales of cotton selected for equal value.

Table II gives the total percentages of visible and invisible waste discarded by the respective waste-cleaning machines. The percentages here given are based on the net weight of cotton fed into the opener picker.

TABLE II.—*Visible, invisible, and total waste percentages.*

[Based on net weight of cotton fed into the opener picker.]

Kind of waste.	Lot No. 1		Lot No. 2.		Lot No. 3.		Lot No 4.	
	Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated.
Total visible and invisible waste pickers	5.62	4.69	2.61	2.39	3.39	2.31	2.00	2.09
Total visible and invisible waste cards	6.51	7.20	7.23	7.12	11.28	11.03	6.75	8.09
Total visible and invisible waste combers	10.25	10.76	12 50	12.32	10.62	16.46	14.97	15.26
Grand total visible and invisible waste	22.48	22.65	22.34	21.83	25.29	29 80	22.72	25 25

There is no evidence of injury to the cotton indicated by the results of the visible and invisible persentages of waste discarded. In fact, Table II shows that in every case, except lot No. 3, the grand total waste discarded from the fumigated cotton was less than that discarded from the nonfumigated cotton. Should the results have been the reverse—that is, in favor of the nonfumigated cotton to the same extent—the effects of the fumigation might have been seriously questioned. However, since the two tests at the textile school do not disclose any material difference between these lots it is assumed that the differences shown by the mill tests are the result of technicalities.

Moisture Tests.

The results of these tests were substantiated by moisture tests of the fumigated and nonfumigated cotton at the textile school, shown in Table III. The results of these tests indicate that the fumigation had no appreciable effect on the absorptive properties of the cotton.

TABLE III.—*Percentages of moisture in the cotton while in the manufacturing processes*

Process.	Lot No. 2.		Difference.
	Fumigated.	Nonfumigated.	
Fed into opener	8.10	7.76	+0.34
Finished lap	8.09	7.66	+0.43
Card sliver	6.55	7.60	−1.05
Comber sliver	7.08	7.13	−0.05

Spinning Qualities.

The numbers of yarn made at the textile school to ascertain the spinning qualities were 40's and 50's from the 1¼-inch cotton and 10's, 20's, 30's, 40's, 50's, 60's, 80's, and 100's from the 1½-inch cotton. Close observations were made by the men who actually were running the machines and also by those supervising the work and no difference was observed in the general spinning qualities.

Tensile Strength.

In order to ascertain the tensile strength comparisons of the different lots of fumigated and nonfumigated cotton, a number of bobbins of the different numbers of yarn were sent from the textile school and the mills to the laboratory of the Office of Markets and Rural Organization of the Department of Agriculture for test purposes.

These tests were made by reeling off, in skeins of 120 yards each, the same numbers of yarn made from the different lots. The skeins were placed on racks (Method originated by Dr. N. A. Cobb of Plant Industry, U. S. Department of Agriculture.) in order to keep them separate and to avoid tangling, after which they were removed one at a time in rotation and broken with a power yarn-tester, the downward stroke of the traverser moving at the rate of approximately 12 inches per minute. Hourly humidity records were taken and the humidifier was regulated accordingly in order to maintain as nearly as possible a constant relative humidity of 65 per cent.

Table IV gives the results of the tensile-strength tests.

Lots Nos. 1 and 2, respectively, represent the two lots of 1¼-inch and 1½-inch Egyptian cotton manufactured at the textile school, while Nos. 3, 4, 5, 6, and 7 represent five lots of cotton, each manufactured by a different representative manufacturing company. The small variations in the various numbers of yarn were standardized for comparison. The differences in tensile strength, in some instances, were in favor of the fumigated and, in some instances, in favor of the nonfumigated cotton.

Table IV.—*Tensile strength comparisons*

(Made in Yarn Testing Laboratory of the United States Department of Agriculture.)

Number of yarn.	Lot No. 1.		Lot No. 2.		Lot No. 3.		Lot No. 4.		Lot No. 5		Lot No. 6.		Lot No. 7	
	Breaking strength in pounds per skein of 120 yards.		Breaking strength in pounds per skein of 120 yards.		Breaking strength in pounds per skein of 120 yards.		Breaking strength in pounds per skein of 120 yards.		Breaking strength in pounds per skein of 120 yards.		Breaking strength in pounds per skein of 120 yards.		Breaking strength in pounds per skein of 120 yards.	
	Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated.	Fumigated	Nonfumigated.	Fumigated	Nonfumigated.	Fumigated.	Nonfumigated
15's					302.11	303.9								
20's													108.48	102.70
22's									102.30	100.45			115.38	115.48
40's	39.98	37.56												
50's	27.29	27.35												
55's							27.51	28.20						
75's											21.88	26.05		
80's			26.45	28.05										
84's							8.32	7.60						

It will be observed that in lot No. 3 the fumigated cotton produced the stronger yarn; in lot No. 4 the reverse was true.

Single-Thread Test.

In addition to the tests shown in Table IV several tests were made with a single-thread testing machine.[1] The results of these tests are shown in Table VI. The results of the single-thread tests are recorded in ounces, while the tensile strength in pounds per skein of the yarn taken from the same bobbins from which the single-thread tests were made is also given. In all cases where the skein tests are given in connection with the single thread tests, the yarn was taken from the same bobbins.

Table V.—*Tensile strength comparisons.*

[Made by two representative cotton mills.]

Number of yarn.	Lot No 3—Breaking strength in pounds per skein of 120 yards.		Lot No. 4—Breaking strength in pounds per skein of 120 yards.	
	Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated
27's	114.8	112.8		
57's			30.25	30.60

The single-thread tests, judged from the comparative uniformity of breaks, did not disclose any superiority, either in the yarns made from the fumigated or from the nonfumigated cotton.

Table VI.—*Single-thread test*

[Made at the New Bedford Textile School.]

	Number of yarn.	Lot No. 1.		Lot No. 2	
		Fumigated.	Nonfumigated.	Fumigated.	Nonfumigated.
Ounces per single thread	40's	5.48	5.53		
Pounds per skein 60 yards	40's	49.3	46.9		
Ounces per single thread	30's			14.80	15.10
Pounds per skein 60 yards	30's			56.25	56.50
Ounces per single thread	60's 2-ply			16.58	16.41
Pounds per skein 60 yards	60's 2 ply			58.20	60.50

Two of the mills reported their findings as to the tensile strength of the cotton yarns they manufactured. These results are shown in Table V, under lots No. 3 and No. 4.

CHEMICAL LABORATORY TESTS.

Investigations also were made in the laboratory of the New Bedford Textile School[1] to ascertain whether cotton treated with hydrocyanic-acid gas lost any of its bleaching, dyeing, or mercerizing value. The following numerical designations represent the cotton and cotton yarns used in these laboratory tests:

KIND OF COTTON.

Sample
No.
1. 1¼-inch Sakellaridis Egyptian—fumigated.
1a. 1¼-inch Sakellaridis Egyptian—nonfumigated.
2. 1½-inch Sakellaridis Egyptian—fumigated.
2a. 1½-inch Sakellaridis Egyptian—nonfumigated.
8. Peruvian cotton, from center of bale—fumigated.
9. Peruvian cotton, from outside of bale—fumigated.
10. Peruvian cotton, from center of bale—nonfumigated
11. Peruvian cotton, from outside of bale—nonfumigated.
12. Peruvian cotton, from center of bale—fumigated.
13. Peruvian cotton, from outside of bale—fumigated.
14. Peruvian cotton, from center of bale—nonfumigated.
15. Peruvian cotton, from outside of bale—nonfumigated.

Samples 1 and 1a, respectively, represent the fumigated and non fumigated 1¼-inch sakellaridis Egyptian cotton, the two bales from which these samples were taken being previously referred to as lot No. 1. In a like manner 2 and 2a represent the 1½-inch fumigated and nonfumigated cotton previously referred to as lot No. 2. Samples 8 to 15, inclusive, were selected from Peruvian cotton received from a manufacturing company. The cotton in samples 1, 2, 8, 9, 12, and 13 was fumigated with hydrocyanic-acid gas.

---

[1] These strength tests were made by William Smith, professor in charge of the Carding and Spinning Department of the New Bedford Textile School, New Bedford, Mass.

[1] These tests were made by Everett Hinckley, professor in charge of the Department of Chemistry and Dyeing, New Bedford Textile School, New Bedford, Mass.

Bleaching of Raw Cotton.

Samples of Nos. 2 and 2a were bleached by treating as follows:

Method *a*. Not scoured. Bleached with a solution obtained by the electrolysis of salt containing 0.5 gram of chlorine per liter. In future this solution will be designated as "electrolytic chlorine."

Method *b*. Scoured in a solution containing 1 gram of soda ash in each 10 cc. then bleached as in *a*.

Method *c*. Treated with 2 per cent. acetic acid and bleached as in *a*.

Finally all the samples were blued with 0.001 per cent. of blue-violet acid dye.

Methods *a*, *b*, and *c* are the usual processes for obtaining white cotton for spinning except that the usual quantity of bleaching agent used was reduced in these tests in order to magnify any variation in the results obtained. No differences in the results of any of the methods on the two samples were apparent, which indicates fumigating the cotton with hydrocyanic-acid gas had no appreciable effect upon the bleaching qualities of the cotton used in any of the tests.

To test the effect of fumigation on the various bleaching agents commonly used the following tests were carried out on samples No. 2, 2a, and 8 to 15, inclusive:

Method *d*. The cotton was boiled two hours in a 10 per cent. solution of soda ash and bleached cold in "electrolytic chlorine" containing 2 grams of Chlorine per liter.

Method *e*. The cotton was treated as in *d* except that chloride of lime solution containg 8 grams of chlorine per liter was used as the bleaching agent.

Method *f*. The cotton was treated as in *d* except that an alkaline solution of sodium peroxide equivalent to 15 grams of chlorine per liter was used. After bleaching all of the samples were blued as in methods *a*, *b*, and *c*.

The concentrations of bleaching agent are similar to those used in practice to obtain equal bleaching value. Close examinations were made of the samples by constructing a sample sheet with the different samples placed thereon for comparison. This comparison gave no indication that fumigation of cotton alters the bleaching value.

All of these tests were carried out on all of the samples of cotton.

To confirm these results, five 1-pound samples of Nos. 2 and 2a were treated by method *d*, the following details being observed in connection with the bleaching: After scouring, the cotton was rinsed 30 minutes in cold water, squeezed, and treated 2.5 hours cold with "electrolytic chlorine," 1.46 grams of chlorine per liter; was rinsed well, treated 30 minutes in a 5 per cent. solution bisulphite of soda, cold; was rinsed well, and blued with a solution containing three-fourths of a gram vat blue in 10 liters of water.

Samples 10, 11, 14, and 15 were combined into one lot, samples 8 and 9 into a second lot, and samples 12 and 13 into a third lot, and each lot was bleached by the method outlined in the previous paragraph for samples Nos. 2 and 2a.

By comparison of these samples it was evident that there was as much difference in bleaching quality between the two bales of nonfumigated cotton as there was between the bales of fumigated and nonfumigated cotton of the same quality.

Description of Further Test.

Samples of fumigated and nonfumigated Chinese cotton which had been both bleached and blued by a representative cotton mill were submited for examination. As a result of the bluing process, the sample of fumigated cotton was a more intense blue than the sample of nonfumigated cotton. On receipt, tests were made on these samples for iron to ascertain if there had been a formation of Prussian blue, due to the presence of hydrocyanic acid in the fumigated cotton, which would cause the intensifying of the color of the cotton. Negative results were obtained. The bluing matter was extracted with water until the samples were practically the same color. These water extracts were of different depths of blue. The deepest extract was then diluted until both were of the same shade of blue. The extracted cotton samples were treated again in their respective solutions. The resultant samples were of the same color.

From the above results the conclusion was reached that the increased depth of blue on the fumigated sample was because it had been treated with a greater quantity of bluing and not because of the presence of hydrocyanic acid or because of any chemical change in the fiber such as the formation of hydrocellulose.

Test for the Presence of Hydrocyanic Acid.

Small specimens from each of the following samples, 2, 2a, and 8 to 15 inclusive were tested for the presence of hydrocyanic acid as follows:

The sample was covered with a solution of 10 c. c. of distilled water, 5 drops concentrated sulphuric acid, 5 c. c. 2/normal ferrous sulphate and 6 c. c. normal solium hydroxide heated nearly to a boil then 5 c. c. 6/normal hydrochloric acid were added.

These tests gave no blue coloration which indicated the absence of hydrocyanic acid in all of the samples at the time of treatment.

Bleaching of Yarns.

The material used in these bleaching tests consisted of yarn made from the following samples of cotton: 1 and 1a, 2 and 2a. Samples 1 and 2 had been fumigated, and samples 1a and 2a were nonfumigated.

All four samples were treated as follows: Boiled for two hours in 10 per cent. solution of soda ash at atmospheric pressure, rinsed until free from alkali, then divided into two lots, each lot containing one-half of each of the above four samples. One lot was bleached by method A, the other by method B, as follows:

Method A. Treated cold for two hours in a 2° twaddle solution of bleaching powder, containing 5.82 grams of chlorine per liter, rinsed with cold water, soured with 2 per cent. solution of acetic acid, rinsed and antichlored in a 2 per cent. solution of sodium bisulphite 30 minutes, then finally rinsed and blued in water containing 1 gram of vat blue in each 13 1/3 liters.

Method B. Treated as in method A, except that a solution of electrolized salt containg 2.87 grams per liter of available chlorine was used as the bleaching agent.

The tensile strength and the number of the yarn of all four samples were taken before and after treatment with bleach A and beach B with the results as shown in Table VII.

Table VII.—*Tensile strength of yarns before and after bleaching.*

Sample No.	Grey			Bleach A			Bleach B.		
	No of yarn.	Skein breakage, 60 yards	Single-thread breakage	No of yarn.	Skein breakage, 60 yards.	Single-thread breakage.	No. of yarn	Skein breakage, 60 yards.	Single-thread breakage
1	26.4	44.8	10.9	29.2	36.8	8.7	29.1	14.1	10.4
1a	26.4	45.7	10.9	29.2	39.4	8.9	29.4	43.8	9.7
2	41.5	42.4	9.8	47.2	7.7	7.9	46.5	34.6	8.9
2a	41.5	43.2	9.8	47.2	29.3	8.0	46.5	39.0	9.1

In this table the tensile strength[1] is given in pounds for the skein breaks and in ounces for the single-thread breaks. The skeins were taken from the same bobbins of which the single threads were tested. From the comparisons of these figures it will be seen that the differences in strength between the fumigated and nonfumigated cotton are so small that it would be unsafe to say that these yarns contained in them any substance such as acids that would reduce the tensile strength of the yarn by releasing the bleaching agent too rapidly.

Dyeing of Yarns.

Portions from all of the four samples of yarns, namely, 1, 1a, 2, and 2a, were bleached according to method A and method B, except that they were not blued. Instead some of the portions were dyed pink and some were dyed blue with both direct and basic dyes.

Direct Dyes.

Method of application.—Dyed in a bath containing 0.1 per cent. benzo rhoduline red B, 5 per cent. of salt, 0.5 per cent. soluble oil. Volume of dye bath equals 25 times the weight of the goods. The goods were entered into the dye bath cold and temperature raised to a boil in 30 minutes, boiled 15 minutes, and allowed to cool in the bath 15 minutes. To obtain the light blue the goods were dyed in the same manner, except 0.1 per cent. benzo fast blue BN was used instead of the benzo rhoduline red B.

Basic Dyes.

Method of application.—Mordanted in a solution containing 0.015 of a gram of tannic acid in each 100 cc. The goods were entered into the dye bath cold and temperature raised to 190° in 45 minutes, then allowed to cool overnight, rinsed and treated cold for 15 minutes in a bath containing 0.01 of a gram of tartar emetic.

The pinks were dyed in a bath containing 0.05 per cent. of rhoduline red B, 0.5 per cent. of acetic acid, cold 30 minutes, then raised to 140° during 30 minutes. The blues were dyed as the pinks, except that 0.05 per cent. of methylene blue BB was used.

No practical difference was seen between the whites obtained on samples 1 and 1a or on 2 and 2a, respectively, where the same bleaching agent was used. Nor could it be seen that the fumigation had made the cotton either more easy to dye or more difficult to dye with direct or basic dyes.

Mercerizing of Yarns.

Samples of yarn made of each of the above four cottons, namely, 1, 1a, 2, and 2a, were mercerized by commercial methods at one of the mills in New Bedford, Mass., and these samples were subsequently tested for their tensile strength and degree of mercerization. In Table VIII the results of the average number of the yarn and tensile strengths, ascertained before and after mercerization, are shown.

Table VIII.—*Tensile-strength tests of natural gray and mercerized yarns.*

Sample.	Natural gray			Mercerized.		
	No. of yarn.	Strength in pounds per skein of 60 yards.	Strength in ounces per single thread.	No. of yarn.	Strength in pounds per skein of 60 yards.	Strength in ounces per single thread.
1	20.84	58.6	13.8	22.0	70.0	20.2
1a	20.84	59.9	13.9	22.0	71.2	21.0
2	30.5	56.0	15.0	30.7	66.0	19.9
2a	30.6	58.5	15.2	30.7	68.1	20.2

From Table VIII it will be seen that the gain in tensile strength due to mercerization is a trifle greater for the nonfumigated than for the fumigated cotton.

The tests for the degree of mercerization were made by dyeing samples of the fumigated and nonfumigated mercerized yarns in 1 per cent. benzo purpurin 4 B, 10 per cent. salt, 1 per cent. soluble oil, 30 minutes at 160°, volume of bath equal to 100 times the weight of goods treated. The same weight samples of mercerized Egyptian yarn were dyed in the same bath after dyeing the fumigated and nonfumigated samples. These exhaust skeins furnished a means of measuring the degree of mercerization, for the better mercerized samples absorb more dyestuff and consequently leave less in the dye bath. In order to ascertain more accurately the degree of mercerization, a sheet of samples was prepared by dyeing mercerized Egyptian cotton with the percentages of dyestuffs shown in Table IX. Salt and soluble oil was used as in method given above, benzo purpurin 4 B being used as the dyestuff.

---

[1] Tests made by Professor Smith.

TABLE IX.—*A set of color standards.*

Standard No.	1	2	3	4	5	6	7	8	9
Dye, per cent	5	4.5	4	3.5	3	2.5	2	1.5	1
Salt, per cent	20	20	20	20	20	20	10	10	10
Soluble oil, per cent	2	2	2	2	2	2	1	1	1
Standard No.	10	11	12	13	14	15	16	17	18
Dye, per cent	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
Salt, per cent	10	10	10	10	10	10	10	10	10
Soluble oil, per cent	1	1	1	1	1	1	1	1	1
Standard No.	19	20	21	22	23	24	25	26	27
Dye, per cent	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01
Salt, per cent	10	10	10	10	10	10	10	10	10
Soluble oil, per cent	1	1	1	1	1	1	1	1	1

The samples of colored yarns obtained by dyeing in the exhaust bath were matched against the standards, and it was found that cotton No. 2a (nonfumigated 1½-inch Egyptian cotton) dyed a lighter shade, indicating a greater degree of mercerization than cotton No. 2 (fumigated 1½-inch Egyptian cotton). But results from lots 1 and 1a fumigated and nonfumigated, respectively, were practically identical.

Conclusion.

The results of these tests indicate that the fumigation of cotton with hydrocyanic-acid gas does not affect, to any material extent, the percentages of waste, spinning qualities, tensile strength, bleaching, dyeing, or mercerizing properties of the cotton.

PURE OXIDE OF URANIUM PREPARED BY NEW METHOD

For a process for the purifying of uranium compounds and for a process for preparing oxides of uranium, two patents have been granted to Charles L. Parsons, Chief Chemist of the U. S. Bureau of Mines. These patents have been dedicated for the free use of the people.

The process for the preparing of uranium oxide is of special importance at this time owing to the fact that it is now definitely known that the Germans are using uranium steel in some of their large cannon, and this process will enable pure black oxide of uranium to be obtained for the use of producing ferro-uranium. Experiments in the production of uranium steel itself are now under way. By the use of the process above mentioned the production of pure oxide of uranium is very much facilitated and cheapened. Also the product is obtained in a much purer form than has ever been acquired heretofore. Uranium oxide so obtained is also valuable for coloring glass, giving to glass the golden yellow color seen in some of the newer forms of automobile headlights. In connection with the uranium work of the bureau, considerable quantities of uranium were produced, and the methods here referred to permit this to be converted into useful forms of commerce.

GOVERNMENT REPORT ON SHALES YIELDING PETROLEUM

The gasoline engine has now become so essential in manufacturing and in transportation that the possible early exhaustion of our natural supply of petroleum, the primary source of the "gas," has become a "burning question," and any data regarding substitutes and possible sources of supply are sought with great interest. Bulletin 641-L of the United States Geological Survey, Department of the Interior, on the "Oil Resources of Black Shales of the Eastern United States," by George H. Ashley, just published, gives information showing the richness and distribution of certain shales, which on distillation will yield oil, gas and ammonia. The report gives the results of tests by the Bureau of Mines of samples of Devonian and Carboniferous shales collected by the Survey geologists at 42 localities in seven States east of the Mississippi, and a rough estimate of the quantity of oil that may be obtained by the distillation of the available shale in a part of this area. The yield of oil from most of the samples examined was small, averaging about 10 gallons per ton of shale—a yield too low for commercial extraction under conditions likely to arise in the near future. Nevertheless the deposits are of interest as indicating the wide extent of shales of this character. The richer beds may possibly be utilized in the future in ways or through processes not now foreseen.

A copy of Bulletin 641-L may be had free of charge on application to the Director of the United State Geological Survey, Washington, D. C.

Adamson to Represent Maritime Corporation.

Announcement has been made by the Maritime Coaling Corporation, of Wilmington, Del., chemicals, etc., of the appointment of P. Chauncey Adamson, 25 Broad Street, Manhattan, as their representative in the State of New York.

International Chemical Co.

The International Chemical Company of Seattle has been incorporated with a capital of $15,000. Will deal in salt cake, anhydrous soda sulphate, glauber's salts, silicate of soda, sulphate of potash, kieselguhe, etc. The incorporators are P. D. Donaldson, H. B. Brown, Alex Neven, Day Karr, G. W. Gregory.

THE COAL TAR DYESTUFF INDUSTRY

I. F. Stone.

Its Development and Permanency in the United States

By I. F. Stone*

In the Accompanying Article, Mr. Stone Shows That, Thanks to Factories Capable of Producing the Colors Necessary for Consumption, an Adequate Tariff Protection by the Government, a Strong Financial Condition Established During the War, and the Preference of American Consumers for American Products, We have Made Certain Both the Development and Permanency of the American Dyestuff Industry.

Before entering upon a discussion of this subject it will be well to consider beforehand a brief sketch of the history of the coal tar dyestuffs industry from the time of its inception in this country. The first American aniline factories were established about 1875. By 1880 there were some ten factories engaged in the manufacture of these products, and it looked as though the industry would be highly successful, for tariff conditions at that time were favorable to this form of enterprise.

Unfortunately, however, a new tariff law was passed three years later which reduced the protection on colors to such an extent that a profitable maintenance of the industry was no longer possible. As a consequence, most of the factories ceased all production until at one time there were only three engaged in this manufacture. The operation of these three was continued by their owners in the hope that some day conditions would change for the better, rather than for immediate gain, and one of the factories actually lost a large amount of money before it finally reached success in about 1900.

About 1898 another factory was established, and 1914 saw the establishment of still another, so that in the latter year, at the beginning of the present European war, there were five factories actively engaged in this industry. Owing, however, to the intense competition of the European manufacturers, especially the Germans, none of these factories were successful enough to make a complete line of colors, and were restricted to the production of only a few of those which could be made to advantage in this country. Therefore the industry was not a large one and was not running to any considerable extent.

Hampered By Lack of Domestic Intermediates.

One reason why the industry could not operate successfully was the lack of what we call intermediate products, that is, products made from benzole and naphthalene (coal tar derivatives) which are the bases of the manufacturing of practically all aniline colors. With one exception, which I will mention later, none of these intermediate products were manufactured in this country up to 1914, when the war began.

The American manufacturers were therefore obliged to rely entirely upon European factories for their raw materials—in other words, the intermediate products—and naturally, the European manufacturers charged them such a price that they could not successfully compete with the finished colors of Europe, which were made from the same intermediate products, but which were, of course, secured by the European manufacturers at a lower price than they could be secured by the American manufacturers who imported them.

The single exception to this statement is that in 1910 a factory for the manufacture of one of the intermediates, viz,: aniline oil, was established, but had not been at all successful up to the time of the war, owing to European competition, the European manufacturers, by the way, having reduced their price immediately upon the establishment of this American factory.

Situation Becomes Acute.

The situation was then, in 1914, when the war began, that no intermediate raw materials were manufacturd here with the exception of this comparatively small amount of aniline oil. Then the supplies of these intermediate products from European factories, that is, German factories, were immediately cut off, just as were the supplies of the finished aniline colors, and the American manufacturers therefore were not able to relieve the situation except to the extent of using up what raw materials they had on hand, which, of course, were not nearly enough to be of any perceptible help to the consumers of aniline dyes.

A few months after the war started, say about January 1, 1915, the situation had become very acute, as practically all the stocks of imported colors which were here at the beginning of the war had been consumed, as had also the raw materials employed by the American factories in their manufacture of colors, the one exception being a factory which had previously been receiving its aniline oil from the American manufacturer, and therefore it was enabled to continue this manufacture of colors without any particular interruption, except the interruption of the lack of foreign intermediates, of which, however, it fortunately had a large stock.

---

*President of the National Aniline and Chemical Company, vice president of the Schoellkopf Aniline and Chemical Works, Inc.

I am not mentioning names of any of these factories in this article as I wish to be absolutely impersonal, but there is no question but that the position of this factory just mentioned, with its supply of raw materials, was a great relief to the consumers of dyes in this country, and it was very fortunate for them that a factory had been established for the manufacture of aniline oil, and that as American manufacturers of colors they had taken the precaution to secure their supply from this American factory, even though they were obliged to pay a higher price than they could have imported the oil for at the time. They preferred, however, to do this in order to encourage the American manufacturers of these intermediate products.

Very soon after the war began, however, it became apparent that there would be a great necessity for the manufacture of these intermediate products in this country, and as the basic material, that is, coal tar, is of course a large domestic product, it was then only necessary to recover its derivatives, such as benzole and naphthalene, and benzole, being particularly needed for explosives and other war purposes, was the first product which had the attention of the American producers.

Production of Benzole Increased.

The production was increased gradually until it has reached at the present time something like 30,000,000 gallons annually as against about 3,000,000 gallons prior to the war, and the production of naphthalene has also increased largely owing to its demand for use as a raw material in the manufacture of these intermediates, although not to such an extent as benzole.

The manufacture of intermediates gradually increased to such an extent that there are now being manufactured a large variety, such as alpha-naphtylamins, beta-naphtol, benzaldehyde, benzyl acetate, chlor-benzole, dimethylaniline, di-nitro-benzole, di-nitro-phenol, nitro benzole, paranitraniline, paraphenylene-diamine, toluidine and others too numerous to mention, so that American manufacturers of colors are now able to get a fair supply of these intermediates, and therefore are enabled to make a more complete line of colors than was possible at the outbreak of the war.

As I have previously mentioned, the first large intermediate to be manufactured, however, was aniline oil, the factory which originally manufactured it before the war immediately increasing its production, and many other concerns starting in later on until it came to a point where the production was fully if not more than equal to the demand, and the fact is, that factories making this product are in such a strong position that it is doubtful whether it will ever again be imported from Europe to advantage.

Another intermediate, the manufacture of which was commenced largely, was chlor-benzole, which is used in the manufacture of sulphur black, a very important color for cotton goods, and for which there is a large sale. The manufacture of this color, by the way, is now so large that it is fully equal to the consumption, and is another product which will probably never be imported again to advantage. Other intermediates followed-until, as I have said, at present we are able to obtain sufficient variety to manufacture a line of colors which will probably take care of the necessary shades, which includes blacks, blues, browns, reds, yellows, greens, orange, violet; the seven primary colors, from mixtures of which practically every shade can be obtained for all materials such as wool, cotton and silk.

An Abundance of Blacks.

It has been stated that American manufacturers are not on a firm basis for the reason that they followed the lines of the least resistance in making colors, that is, made the colors which were easiest to manufacture, and that when the war is over and competition comes again from Europe they will not be able to stand against it. This opinion is not true, in that while it is true that they did follow the lines of least resistance, it so happened that the colors manufactured were the ones most largely consumed, such as blacks, for instance. This is by far the color most largely consumed, being practically half of the entire color consumption of the country, and this was the first color to receive attention of the American manufacturers, it being obvious that a color which could be manufactured in large quantities would mean a less cost for overhead expenses.

Therefore there is now an abundance of blacks made for all purposes, sufficient to take care of the whole consumption of the country, for instance:—Direct blacks for cotton, union, wool and silk, azo black or acid black for wool and silk, sulphur black for cotton (already mentioned), chrome blacks for wool, and nigrosines for leather, inks, etc., so that this particular color is very well taken care of.

Consumers can get the necessary quantity for consumption next year if they were careful to contract for same in time to allow the American manufacturers to arrange their facilities and buy the raw materials necessary to take care of such contracts for 1917.

The next color in importance, which had their attention, was blue, this being next to black in the proportion of consumption. They are now producing blues for the same textiles, viz: wool, cotton and silk, to a very satisfactory extent.

All Necessary Shades Produced.

The production of other colors has followed in the order of their importance, so that now practically all shades are produced. To illustrate clearly the rapid development of this industry, I would point out that whereas there were only five factories making aniline dyes in the United States prior to the fall of 1914, when the war began, we now have a total of about 120 making intermediates and anilines, and, as I have stated above, their whole production will take care of the entire country as far as the necessary colors are concerned.

Special colors, although not now manufactured in this country, such as Indigo, vat colors and some specialties for particular purposes, are in prospect, and it is, I believe, only a question of a comparatively short time when a complete line will be manufactured here.

It being a fact that the American manufacturers are now able to produce all of the necessary colors, needed, the question, then, is whether this will be a permanent industry or whether the conditions which prevailed before the present war will again be the same—that the European manufacturers may be able to flood the country with their colors at prices with which the American manufacturer cannot compete. It gives me much pleasure to be able to answer this question very definitely in the affirmative, viz: the dyestuff industry in this country is now on a permanent basis for the following reasons:

Industry Firmly Established.

First—The production of coal tar derivatives, like benzol and naphthaline, has been increased to such an extent that the quantities produced are now from ten to twenty times more than before the war, and the manufacturers of intermediates, depending on these products, will continue to be able to get a full supply of them at prices which will compare favorably to European prices on account of this largely increased production, it being well known that the United States has practically inexhaustible supplies of coal, which is the base product, and from which will be derived the benzol and naphthaline and other products necessary for the manufacture of the intermediates which, in turn, produce the finished colors.

Second—The United States Government has finally discovered that in order to make this industry permanent it is necessary to give more adequate tariff protection; therefore a tariff bill, known as H. R. 16763, was passed in 1916 giving a protection of 30% ad valorem and 5c per pound specific duty on finished colors, and 15% ad valorem and 2½c. per pound specific duty on intermediates,—the addition to the old tariff being the 5c. and 2½c. per pound specific duties just mentioned, and this additional protection gives the American manufacturers a very much better opportunity to operate, although, even at that, a higher protection would be still more important if it could be obtained. The exception to the above protection is that on indigo, and on what are known as indigoids and alizarine colors, no specific duty was imposed, although they were given the 30% ad valorem duty as against the fact that they were free before this bill was passed. There is no specific reason why these colors should not also have this specific duty and why they were excepted in the passing of this bill is a question for those who passed it to answer, but I believe that upon mature consideration this exception will be canceled and all of the colors now manufactured in this country will have the same protection.

Third—The manufacturers of intermediates and colors have, during the war, been able to obtain, owing to abnormal conditions, an abnormal rate of profit, and out of this abnormal profit they have been able to build and pay for their factories as well as accumulate a surplus profit which they can use for the further increase of their present production and the working out of the special colors not manufactured here at present.

Fourth—The American consumers have realized, due to the conditions prevailing since the war, the importance of having an aniline industry in this country which will in the future prevent a repetition of the conditions which prevailed just after the war began, when it was for some time impossible to secure enough colors for the consumption of the country, and as a consequence of which many consumers were obliged either to run their mills or factories only a part of the time, or, as in some cases, close down entirely. With this realization, therefore, they will undoubtedly give the preference to American made products, which, in itself, would help in the competition against European manufacturers after the war.

To sum up briefly the whole question of the development and permanency of the coal tar dyestuff manufacturing industry in the United States, it is apparent from the above that with factories capable of producing the colors necessary for consumption, an adequate tariff protection by the Government, a strong financial condition established during the war, and the preference of American consumers for American products, we have certainly insured both the development and permanency of the American dyestuff industry.

Special Research Study for Professors Rose and Trumbull.

Beginning about June, one year of research study on tanning and various phases of physical chemistry will be spent at the Mellon Institute of Industrial Research, Pittsburg, Pa., by Professors Robert E. Rose and Harlan L. Trumbull, of the University of Washington.

ELECTROCHEMISTS HOLD THIRTY-FIRST GENERAL GATHERING IN DETROIT

Attended by nearly 200 members from various parts of the country, the thirty-first general meeting of the American Electrochemical Society, held in Detroit from Wednesday, May 2, to Saturday, May 5, proved to be one of the most successful in the history of the organization. In all, four technical sessions were held, as well as the annual business meeting. The former saw the presentation of an unusually large number of excellent papers, many of which are published in full or in abstract in the current issue of "Metallurgical and Chemical Engineering." The social and semi-social events included visits to the Dodge, Ford and Packard automobile factories; visits to the electric steel plants of the Michigan Steel Castings Co. and the John A. Crowley Co.; a whitefish dinner at the "West Wood," a theatre party, and, most notable of all, a smoker on the roof garden of the Hotel Tuller. The latter gathering brought forward much poetical and histrionic talent which achieved its greatest triumph in the production of a play entitled "Research in Hell, A Futurist Impression of Mephistopheles' Research Laboratory" which was rapturously received.

DR. COLIN G. FINK.
[Courtesy of "Metallurgical and Chemical Engineering."]

Officers For the Coming Year.

At the business meeting, held Thursday morning in the ballroom of the Hotel Statler, officers were elected as follows:

President, Dr. Colin G. Fink, head of the Research Laboratory of the Edison Lamp Works, General Electric Company, Harrison, N. J.; vice-presidents, H. C. Parmelee, Dr. F. C. Frary, and John Wood Beckman; managers, L. E. Saunders, Dr. John A. Mathews and A. T. Minckley, and treasurer, Pedro G. Salom. Dr. Joseph W. Richards was re-elected secretary.

Dr. Fink, the new president, who succeeds Francis A. J. Fitzgerald, graduated from Columbia University in 1903, following which he spent four years in the Otswald laboratory at Leipzig, where he acquired his doctor's degree. He is chiefly known for his discovery of "ductile" tungsten, while one of the important products of his laboratory is the platinum substitute leading-in wire, which consists of a compound copper or cobalt wire with a corrected expansion coefficient, and which resulted in the conservation of platinum to the extent of millions of dollars annually.

The fall meeting of the Society will be held from Wednesday, October 3, to Saturday, October 6, in Pittsburgh.

Original Papers.

Among the original papers presented during the four technical sessions, the following are included:

"Comments on the Electric Steel Industry," by Dr. John A. Mathews, president of the Halcomb Steel Co., Syracuse, N. Y.

"The Electric Furnace in the Steel Casting Plant," by R. F. Flinterman, president of the Michigan Steel Castings Co., Detroit, Mich.

"Notes on Electric Steel Melting," by J. L. Dixon, of the John A. Crowley Co., Detroit, Mich.

"A Description of the Bethlehem 10-Ton Girod Steel Furnace," by C. A. Buck, of the Bethlehem Steel Co., South Bethlehem, Pa.

"Electric Characteristics of Electric Furnaces," by A. A. Meyer, of the Detroit Edison Co.

"Improvements in the Rennerfelt Electric Furnace," by C. H. vom Baur, associated with Messrs. Hamilton and Hansell.

"The Grinding Wheel—A Connecting Link Between the Electric Furnace and the Automobile," by R. G. Williams.

"Chemistry of the Flaming Arc in Relation to Luminescence," by William Roy Mott, of the National Carbon Co.

"The Vosmaer Phenomenon," by Dr. W. C. Moore.

"Acid-Resisting Properties of Some Iron-Silicon Alloys," by Prof. O. L. Kowalke, of the University of Wisconsin.

"Low-Temperature Electrothermal Processes," by C. F. Hirshfeld, chief of the Research Department of the Detroit Edison Co.

"The Current Efficiency in Charging the Edison Storage Battery," by Dr. M. De Kay Thompson and L. R. Byrne of the Massachuetts Institute of Technology.

(Continued on Page Following)

"Magnetite Electrodes," by Dr. M. De Kay Thompson and T. C. Atchison.

"Electrolytic Pickling of Steel," by Dr. M. De Kay Thompson and O. L. Mahlman, Massachusetts Institute of Technology.

"Tests of Antimony Plating Baths," by Dr. F. C. Mathers and K. S. Means, Indiana University.

"Electrodeposition of Antimony from Fluoride Baths Containing Addition Agents," by Dr. F. C. Mathers, K. S. Means and B. F. Richard.

"Addition Agents in the Electrodeposition of Silver from Uncommon Silver Salts," by Dr. F. C. Mathers and T. G. Blue.

"Essential Oils as Addition Agents in Plating Baths," by Dr. F. C. Mathers and A. B. Leible.

"Electrical Endosmose and Adsorption," by Drs. T. R. Briggs, H. L. Pierson and H. S. Bennett, of Cornell University.

"A Cuprous Oxide Photochemical Cell," by Theodore W. Case, of Auburn, N. Y.

LALANG GRASS AS A NEW SOURCE OF PAPER PULP

From the Indian Trade Journal comes information relative to recent experiments of interest to chemists engaged in the paper industry. The article, reprinted in the U. S. Government's Daily Commerce Reports, follows:

A well-known agricultural and technical chemist in Queensland has conducted very successful experiments in manufacturing paper pulp out of lalang grass, or, as it is more commonly known, blady grass, on account of its great blades which are 4 or 5 feet long. It resembles very closely the esparto of Spain and North Africa, and when dried before making it into pulp yields as high as 60 per cent. of first-class paper-making pulp.

The expert states that esparto is the best pulp known and the blady-grass product is within 10 per cent. of the same value. There are millions of tons of this grass growing in Queensland. Three crops a year can be cut from it, and it is a curse to the country. He is also experimenting with other plants with good results, namely Chinese barr (*Urena*) and the Queensland hemp (*Sida Retusa*). They produce 30 per cent. of first-class paper pulp. Lantana, which is also regarded as a great pest, makes an excellent wrapping paper. Screwpine or pandanus, which also grows prolifically, is likewise being experimented with.

LEEDS CHEMICAL FIRM BUYS COAL-TAR PLANT

According to advices received by the U. S. Bureau of Foreign and Domestic Commerce, Brotherton & Co. (Ltd.), of Leeds, a firm which manufactures ammonia and coal-tar products, has announced the purchase of the Mersey Chemical Works, built by the Badische Aniline & Soda Febrick at Bromborough Port, Dirkenhead, near Liverpool, for the manufacture of aniline dyes. These works were sold at auction in the winding up of alien enemy concerns in this country, and the price paid is given as £135,000 ($656,977). The head of the firm is quoted by the Yorkshire Evening Post, of Leeds, as stating that when the present extraordinary demand for high explosives has ceased, plant and material will go to a considerable extent to the manufacture of coal-tar intermediate products and dyes.

Brotherton & Co. (Ltd) controls works established in chronological order as follows: Leeds, 1882; Stourton, 1888; Birmingham, 1893; Liverpool, 1904; Glasgow, 1904; Sunderland, 1905; Workington, 1913; and Middlesborough, 1913.

REFRACTORIES AND GLASS MIXTURES BEING STUDIED

Investigations of silica brick, graphite crucibles, and glass mixtures are among the branches of scientific work conducted at the United States Bureau of Standards recently with the object of aiding American industries. Some of these tests were in continuation of work which has been progressing from month to month.

In the study of silica brick special attention was paid to the development of a test which will serve readily to determine the quality of this class of brick. Samples are being collected from very widely distributed districts for the purpose of investigating the quality of the brick as furnished. This will supplement work already completed upon which a report is being prepared. The changes that take place in the quarzite used in making this material have been followed microscopically. The bureau prepared 109 specimens. Three burnings were made, totaling 216 pieces, and many volume determinations were made

Use of Natural and Artificial Graphite.

In the study of graphite crucibles, nine different mixtures were used in which there were both natural and artificial graphite. The artificial graphites were those made in both electric furnaces and blast furnaces. The study of the loss of carbon by oxidation, while burning, was continued, and a boxlike specimen of the graphite clay mixtures was prepared, to be used in studying the behavior of these during burning.

At the Bureau's Pittsburgh laboratory three melts were made of boro-silicate glass mixtures, and a mixture was melted giving a light barium crown glass. The latter melt was largely for the purpose of trying out the large kiln. It has been found to heat up in a fairly satisfactory manner, and it is believed that with the use of the large pots and large batches, satisfactory results will be obtained in this furnace. The large pots have been delivered and a melt started which will produce about 500 pounds of glass.

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.

ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

G. S. K.—According to the Chilean Government there is still sufficient unmined nitrate of soda (Saltpeter) in Chile to last another two hundred years. The quantity in the examined ground is:—

	Tons.
Province of Tarapaca	35,000,000
Tocopilla District	28,000,000
Antofagasta (Central)	32,000,000
Antofagasta (Aguas Blancas Dist.)	49,000,000
Taltal	95,000,000
Chanaral & Copiapo	8,300,000
	247,300,000

C. E. B.—The dry residue obtained from the activated sludge process of sewage purification has the following composition:—

Loss on ignition	70.4%
Mineral matter	29.6%
	100.0%
Nitrogen (N)	6.0%
Phosphate (P_2O_5)	4.2%
Grease, fat, etc. (by ether extraction)	7.3%

P. A.—The second claim of the patent you refer to is the strongest of the three, the first and third being limited to the exact form of the apparatus.

R. G. D.—Compounds of silver and vanadium can be used in place of platinum for the manufacture of sulphuric acid by the contact process.

P. A. B.—Full data as to Foreign Trade opportunities can be had at No. 315 Custom House, New York, or 629 Federal Bldg., Chicago, Ill.

B. S. B.—Small quantities of alum added to your water supply will remove the manganese compounds, and if you will forward a gallon sample, I will determine the proper quantity to use in your case.

R. F. D.—The cracking of reinforced concrete has been traced, in certain cases, to the use of brackish water or unwashed beach sand in its preparation. The bursting is caused by the formation of iron oxide on the imbedded metal.

Concrete is also destroyed by the formation of a voluminous, insoluble double compound of calcium aluminate and sulphate ($3CaO, Al_2O_3, 3CaSO_4$).

C. A. H.—The "Black Damp" in mines, which varies from 0.14% to 83%, is an accumulation of carbon dioxid and nitrogen present, in excess percentages, as found in pure atmospheric air.

A. S. T.—Storax, which is much used in the perfumery industry, is impoverished by the removal of cinnamic acid. The compounds of this acid give storax its peculiar odor. Some samples contain as little as 3% although the normal figure is about 30%.

E. A. W.—If you will send a pound sample of the material you mention, a complete chemical examination will be made of it, at a reasonable fee.

W. A. S.—Boiler compounds appearing on the market vary greatly in composition and should be examined and given a steam test before using in your boilers. A 4oz. sample is required for this test.

Charles B. Davis

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail are specifically requested, communications can only be considered in the order of their receipt.—Editor.

DISTILLATES

News Notes of Chemical and Allied Industries

Oils and Minerals.

Great Western Oil & Chemical Company, Oklahoma City, Okla., has been incorporated with a capital of $2,000,000 to deal in oil and minerals of all kinds and to develop the same. The incorporators are R. H. Locke, A. J. McMahon, J. B. Dudley, all of Oklahoma.

Natural Oil and Gas.

The Great Eastern Oil & Gas Company, Aurora, Ind., has been incorporated with a capital of $100,000 to develop oil and gas lands and to market the product of the same. The incorporators are Louis Bloom, H. C. Williams, Aurora, Ind.; E. W. Crispin, J. M. Horless, Gulfport, Miss.; W. H. Bilerz, Belfar.

Chemicals, Dyes and Medicines.

Becker, Pennrich & Co., Inc., New York, has been incorporated with a capital of $20,000 to deal in chemicals, dyes, medicines. The incorporators are H. C. Becker, H. C. Pennrich, E. Brophy, 82 Beam street.

Fire Extinguishers and Chemicals.

American Fire Extinguisher Company, Pittsburgh, Pa., has been incorporated with a capital of $50,000 to manufacture chemicals, fire extinguishers of all kinds. The incorporators are W. A. McCoy, Pittsburgh, Pa.; W. I. N. Lofland, Geo. W. Morgan of Dover.

Window Glass Co.

McCoy Machine Glass Company, Huntington, W. Va., has been incorporated with a capital of $40,000 to deal in window glass. The incorporators are H. E. Camp, M. L. Camp, F. F. Rigall, P. P. Gibson and F. Mearns, Huntington, W. Va.

Edison in New Concern.

New Jersey Products Company, West Orange, N. J., has been incorporated with a capital of $500,000 to manufacture chemicals, glues, veneers, stains and shellac, paper products, phonographs, sound records and storage batteries, etc. The incorporators are Thomas A. Edison, Charles Edison, R. H. Allen, West Orange, N. J.; Stephen B. Mambert, East Orange, N. J., and A. C. Emery, Montclair, N. J.

Miscellaneous Chemicals.

William F. Eissing & Co., New York City, has been incorporated with a capital of $25,000 to deal in chemicals, liquids or solids. The incorporators are L. D. Della, D. F. Bodger, Morte S. Joseph, 299 Broadway.

Nitrogen Products Co.

The Nitrogen Products Company, Providence, R. I., has increased its capital from $200,000 to $500,000.

Glues, Gelatine, Etc.

United Chemical & Organic Products Company has been incorporated in Delaware with a capital of $2,202,700 to manufacture glues, gelatine, etc.

Westmoreland Co. to Improve Plant.

Plans have been filed by the Westmoreland Chemical and Color Company for alterations and improvements to its plant at Twenty-second and Westmoreland streets, Philadelphia, Pa.

Utica Co. Increases Capital.

The Utica Chemical Company, of Utica, N. Y., has increased its capital from $30,000 to $200,000 for expansion.

To Improve Phenol Plant.

The Butterworth-Judson Corporation, Newark, manufacturer of chemicals, etc., will make improvements to its phenol plant, which has been temporarily closed for this purpose.

New Charcoal and Chemical Plant.

Plans are being completed for the construction of a charcoal and chemical plant at Eastside, Oregon, by F. C. Harbaugh, Frank Kester and Fred Blaser. Alderwood and mill waste will be utilized in the inital plant.

Hoffman-LaRoche Increases Capital.

The Hoffman-LaRoche Chemical Works, 440 Washington street, New York, has increased its capital from $25,000 to $125,000 for expansion.

Chemicals.

The Wood-Percival Chemical Corporation, Richmond, Va., has filed articles of incorporation with capital of $300,000 to manufacture chemicals.

Parties to New Dye Merger Consider Further Plans.

At a recent meeting of the new National Aniline and Chemical Company, New York, it was decided to make the Schoellkopf Aniline and Chemical Works at Buffalo the assembling and shipping point for its finished products. The Benzol Products Company, which is also included in the recent consolidation, is erecting a large still-house at its plant at Marcus Hook, Pa., while work on the new buildings at the Beckers Aniline and Chemical Works in Brooklyn is progressing rapidly.

Capital Increase for Utica Co.

The Utica Chemical Company, Utica, N. Y., has increased its capital from $30,000 to $200,000 for expansion.

Colors and Chemicals.

The Peerless Color Company, Inc., Bridgewater Township, N. J., has been incorporated with a capital of $500,000 to manufacture colors and chemicals.

Dilworth Oil and Refining Co.

Dilworth Oil & Refining Company, Newkirk, Okla., has been incorporated with a capital of $1,000,000. The incorporators are J. R. Utterback and W. A. Doty, Newkirk; M. R. Diggs, Chicago.

Chemicals and Chemical Compounds.

The Colfab Manufacturing Company, Philadelphia, Pa., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical compounds. K. G. Bird, Philadelphia, is the principal incorporator.

Paper and Paper Stock.

Frederick G. Marquardt, Inc., New York, has been incorporated with a capital of $25,000 to manufacture paper, paper stock, etc.

J. L. Hoffman Co., Chemicals.

The J. L. Hoffman Company, Allentown, Pa., has been incorporated with a capital of $50,000 to manufacture chemicals. James L. Hoffman is president.

Aniline Dyes and Chemicals.

The Federal Aniline Corporation, New York, has been incorporated with a capital of $10,000 to manufacture and deal in dyes and chemicals. The incorporators are Richard Pick, Doris Lefkowitz, Arnold Blank.

Perfumes, Soaps, Etc.

Sardou, Inc., New York, has been incorporated with a capital of $25,000 to manufacture perfumes, soaps, toilet preparations. The incorporators are A. Keyrouse, B. C. Elliott, G. Sardou, 172 West 109th street.

Klipstein Increases Capital.

E. C. Klipstein & Sons Company, Chrome, N. J., manufacturer of chemicals and dyestuffs, has increased capital from $100,000 to $1,000,000 for expansion.

New Brooklyn Color Works.

Pioneer Color Works, Inc., Brooklyn, N. Y., has been incorporated with a capital of $10,000 to deal in colors and dyestuffs. The incorporators are A. C. Zobel, A. Galer, L. J. Schindler, 923 East Thirteenth street.

Ammonol Chemical Co.

The Ammonol Chemical Company, New York, has reduced its capital from $100,000 to $10,000.

Chemicals and Druggists' Supplies.

National Motor Power Company, Inc., Dover, Del., has been incorporated with a capital of $5,000,000 to manufacture chemicals and to deal in druggists' supplies of all kinds. Jas. Hughes, Mark W. Cole, Mary S. Pollock, all of Dover, Del., incorporators.

Dumas Appointed Georgia State Chemist.

W. C. Dumas, for eight years a member of the firm of A. M. Lloyd Laboratory, Atlanta, Ga., has been appointed State Chemist of Georgia.

Dr. Whitaker Heads U. S. Industrial Alcohol Co.

Announcement has been made of the recent election of Dr. M. C. Whitaker, head of the Department of Chemical Engineering, Columbia University, as president of the U. S. Industrial Alcohol Company. In assuming the duties of this office, Dr. Whitaker will also serve as chairman of the manufacturing committee in charge of plants and operations, chairman of the research committee in charge of the new laboratory at Baltimore, and as a member of the sales committee of the company.

Dr. Nichols to Head Sub-Committee on Chemicals.

Dr. William H. Nichols, of the General Chemical Company, New York, has been appointed by the Council of National Defence as chairman of a subcommittee of the committee on raw materials. The new committee will maintain offices in Washington, D. C. Other members of the committee are: Acids—E. R. Grasselli and Henry Howard. Fertilizers—Horace Bowker and Charles E. MacDowell. Alkalis—J. D. Pennock. Miscellaneous chemicals—Edward Mallinckrodt, Jr.

Prof. Zoller Investigates Possibilities of By-Products from Waste Grapefruit Culls.

In a paper read before the recent Kansas City meeting of the American Chemical Society, Professor Harper F. Zoller, of the Kansas State Agricultural College, described the results of his investigations on grapefruit with a view to utilizing the culls, which may not be shipped. His calculations show that in early winter the culls contain from 4.2 to 4.5 per cent citric acid, while the sugar content averaged 4.4 per cent. By late spring the acid content was reduced to 1.8 per cent, while the sugars rose to 8.5 per cent. Recoverable oil formed from 1.6 to 2.1 per cent of the peel, and a good yield of pectin was obtained from the skins. It was found that freshly picked early fruit is the most favorable for these by-products.

FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Dyes; Perfumes.

23938.—A man in Russia wishes to be placed in communication with American manufacturers and exporters of dyes, boots and shoes, cloth, hardware, machinery, and perfumes. Catalogues, samples, and full information should be submitted.

Medical Picture Slides.

23959.—A doctor in Canada desires to purchase picture slides suitable to accompany illustrated lectures by physicians on public-health subjects, especially on subjects illustrating blood circulation. Quotations should be made f. o. b. New York, Boston, or other eastern city. Payment will be made by cash. Correspondence may be in English.

Lime and Portland Cement.

24110—A firm in Argentina is in the market for three grades of white lime in 220-pound casks and Portland cement in 396-pound barrels, gross weight. Quotations should be made c. i. f. destination. Payment will be made against shipping documents upon receipt of goods. Correspondence should be in Spanish. References.

Potato Starch; Copper Sulphate.

24094—A firm in the United States reports that its agent in Spain is in the market for 3,000 tons (2,204 pounds each) of sulphate of copper for delivery in April, and 2,000 tons for delivery in March and May; 10 to 500 tons of potato starch; sheet tin for packing sweets, covering champagne bottles, and for paper-plated sheets. Samples of the potato fecula should be submitted. Quotations should be made f. o. b. New York.

Drugs and Chemicals.

24096—A firm in Spain desires to secure an agency for the sale of chemicals and drugs, such as aspirin, antipirine, benzoic acid, acetone, aniline colors, aniline arseniate, betel leaves, benzonaphthol, benzoates, bromide of potassium, pure bromide, chloroform, carbonate of guaiacol, cocaine, hydrochlorate and muriate, fluoric acid, heliotropine, camphor oil, mercurial preparations, naphthol, menthol, opium, iodine, iodate of potash, oxide of bismuth, iodoform, ipecac, urate, etc. Quotations should be made c. i. f. destination. References.

Chemicals.

24134.—A commission merchant in Colombia desires to be placed in communication with American manufacturers and exporters of hardware, dry goods, chemicals, drugs, notions, etc., and particularly wheat. A complete list of the articles desired may be obtained from the Bureau or its district offices. References.

Chemical Fertilizers and Chemical Products.

24222.—A man in Spain desires to secure an agency for the sale of chemical fertilizers and other chemical products used in agriculture. Correspondence should be in French or Spanish. References.

Phosphorescent Preparations.

24229.—A firm in Spain wishes to buy phosphorescent preparations other than for dial purposes. Payment will be against shipping documents or by cash. Correspondence should be in Spanish. References.

Chemicals.

24130.—A firm in Spain wishes to secure an agency for the sale of bichromate of soda, bichromate of potash, aniline oil, sulphate of aluminum, alum, and sulphate of copper. Quotations should be made c. i. f. destination. Correspondence should be in Spanish or French. References.

Sugar Substitutes.

24203.—A firm in England is in the market for sugar substitutes, dried milk, and dried or liquid eggs. Quotations should be made c. i. f., if possible. Payment will be made by cash against documents in New York.

Drugs and Chemicals.

With capital stock of $100,000, the H. A. Metz Laboratories, Inc., drugs, chemicals, etc., has been incorporated under the laws of New York by C. Fuehrlein and G. P. and H. A. Metz.

Aniline Colors and Chemical Products.

24245.—A commission merchant in Spain desires to secure an agency for the sale of aniline colors and chemical products. If possible, quotations should be made c. i. f. destination, otherwise, f. o. b. New York. Payment will be made against shipping documents through a local bank. Correspondence may be in English. References.

Acetate of Lime.

24045—A mining engineer in Argentina is in the market for acetate of lime. Quotations should be made f. o. b. American port, per ton or minimum number of tons. He also desires to receive catalogues and terms from American manufacturers and exporters of machinery for making acetic acid. Payment will be made by cash against documents of one-half cash with order and balance against documents. Correspondence may be in English. References.

Chemical Products; Dyestuffs.

24447—An exclusive agency is desired by a commission merchant in Spain for the sale of chemical products of all kinds and dyestuffs for silk, wool, and cotton textiles, or authorization to register purchased goods with his own trade mark. Quotations should be made c. i. f. destination. Payment will be made against delivery of shipping documents. Correspondence should be in Spanish. References.

Colors and Dyestuffs.

24422—A firm in India desires to represent American manufacturers and exporters of colors and dyestuffs.

Chemical Products.

24418—An agency is desired by a man in Brazil for the sale of chemical products, drugs, pharmaceutical products, etc. Quotations should be made c. i. f. destination. Correspondence may be in English. References.

Chemical Products.

24333—A man in France desires to secure an agency for the sale of all kinds of chemical products. Quotations should be made c. i. f. French port. Correspondence may be in English. References.

Chemical Products and Chemicals.

24369—A man in Italy wishes to secure agencies for the sale of chemical products, drugs, pharmaceutical products, paraffin wax, caustic soda, carbonate of soda, vaseline, bronze and aluminum powder, lampblack, raw matetrials for making varnish, lard oil, wood oil, white spirit, and lithopone. Quotations may be made c. i. f. Genoa. Correspondence may be in English. References.

Celluloid in Sheets.

24434—A firm in England wishes to purchase 1,000 sheets of celluloid for making Christmas cards. Samples of the celluloid desired may be examined at the Bureau or its District Offices. (Refer to file No. 84805.) Quotations should be made c. i. f. destination. Payment will be made by cash against shipping documents at destination. The celluloid should be packed in wooden cases. Reference.

Fertilizers.

24064—A firm in Spain wishes to secure an agency for the sale of all kinds of fertilizers. Quotations should be made c. i. f. Spanish port. Correspondence may be in English. References.

Colors and Chemicals.

24410—An agency is desired by a firm in India for the sale of colors, such as methyl violet, methyl blue, logwood extract, etc., and chemicals of all kinds, such as alum, sulphates, sodas, rosin, quicksilver, glycerin, etc. Quotations should be made c. i. f. or f. o. b. destination and Karachi. Payment will be made by 60-day sight draft through a New York firm. Correspondence may be in English. References.

Algarrobilla for Tanning.

24432—A company in the United States acting as purchasing agents for firms in Japan is in the market for positive and negative moving-picture films, lathes, held wire for spinning mills, algarrobilla for tanning, and "motaragaut" gum. Reference.

Colors and Varnishes.

24262—A commission merchant in Spain desires to purchase and secure exclusive agency rights for the sale of water soluble blue ultramarine, and all kinds of colors and varnishes. Quotations should be made c. i. f. destination. Payment will be made against shipping documents at destination. Correspondence should be in Spanish. Reference.

Chemicals for Soap, Shoe Polish, and Tanning.

24269—A firm in the Canary Islands is in the market for machinery and chemicals used in the leather-tanning industry and chemicals used in making soap and shoe polish. Quotations should be made f. o. b. New York. Cash will be paid. Correspondence should be in Spanish. Prices and full information should be submitted.

Petroleum.

24259—A foreign purchasing commission in the United States desires to place orders for large quantities of petroleum, such as is used by the United States Navy.

Chemicals for Aerated Water.

24406—A company in Peru wishes to purchase clear green, transparent, 4 and 8 ounce glass bottles, with glass ball stoppers, for aerated waters, and chemicals used in the manufacture of aerated water, such as bicarbonate of soda, citric acid, sulphuric acid, tartaric acid, etc. Payment will be made by cash against documents through a local bank. Quotations should be made f. o. b. New York or San Francisco. The bottles should be packed in crates or barrels of 1 gross each. Correspondence may be in English. References.

MAY PRICES OF CHEMICALS, ETC.

The New York Wholesale Market on May 16.

CHEMICALS, ORGANIC.

Acetanilid, lb.	.42	@	...
Acetic acid, 28 per cent	4.15	@	4.30
Acetic acid, glacial	.28	@	.30
Alcohol, 190 U. S. P.	3.06	@	3.08
Alcohol, denatured, bbls.	.72	@	.90
Alcohol, wood, 95 per cent	1.00	@	1.02
Alcohol, wood, 97 per cent	1.05	@	1.07
Amyl acetate	3.75	@	4.00
Benzoic acid, Ex Toluol	6.20	@	6.50
Carbolic acid, drums	.42	@	.44
Carbon tetrachloride	.16	@	.16½
Chloroform	.60	@	.62½
Citric acid crystals	.72	@	.75
Glycerine, C. P. drums	.57	@	.58
Glycerine, cans	.58	@	.59½
Glycerine, dynamite	.56	@	.57½
Pyrogallic acid, resublimed	3.15	@	3.25
Pyrogallic acid, crystals	2.90	@	3.10
Salicylic acid	.80	@	.85
Tannic acid, technical	.65	@	.70
Tartaric acid, crystals	.76	@	.83

CHEMICALS, INORGANIC.

Acetate of lime, gray, 100 lbs.	4.50	@	4.55
Alum ammonia, ground	.04¼	@	.04¾
Alumina sulph, iron free	.05	@	.05½
Ammonia aqua, 26 deg., lb.	.06¼	@	.06½
Barium chloride	90.00	@	95.00
Barium nitrate	.12	@	.13½
Blanc fixe, paste	.03	@	.03½
Blanc fixe, powder	.04	@	.04½
Blue vitriol, carlots	.09½	@	.10
Blue vitriol, powdered	.12½	@	.13
Borax, crystals	.07¾	@	.08
Brimstone, ton	45.00	@	50.00
Caustic soda, 76 per cent	.06	@	...
Calcium sulphate	.10	@	.20
Glauber's salt	...		...
Nitric acid, 40 degree, 100 lbs.	6.50	@	6.75
Phosphoric acid, 50 per cent	.23½	@	.25½
Potassium bichromate	.36	@	.37
Potassium bicarbonate	1.20	@	1.25
Potassium chlorate, crystals	.52	@	.59
Potassium cyanide, mixture	.80	@	.95
Sodium acetate	.10	@	.13
Sodium bicarbonate	.02	@	.03½
Sodium benzoate	6.00	@	6.50
Sodium nitrite	.30	@	.40
Sodium phosphate	.05	@	.06
Sodium prussiate	.30	@	.35
Sodium chlorate	.25	@	.26
Sodium salicylate	.85	@	.90
Sodium sulphide	.02	@	.02½
Sulphuric acid, 66 deg.	1.75	@	2.00
Sulphur, flowers	2.95	@	3.10
Tin bichloride	.19¾	@	.20¼
Tin oxide	.66	@	.68
Zinc oxide	.12	@	.14

DYE MATERIALS.

Annatto, cans	.32	@	.33
Aniline, oil	.30	@	.32
Aniline, salt	.32	@	.38
Albumen, blood	.55	@	...
Albumen, egg	.88	@	.90
Albumen, egg yolk	.36	@	.37
Beta naphthol, sublimed	.85	@	...
Carmine, No. 40	4.40	@	4.50
Cochineal, silver, lb.	.51	@	.52
Cochineal, black, lb.	.57	@	.59
Gambier, lb.	.15	@	.15½
Indigo, madras, lb.	1.10	@	...
Logwood, extract, lb.	.11	@	.15
Madder, Dutch, lb.	.25	@	.25½
Myrabolans	40.00	@	45.00
Paranitraniline	1.30	@	1.35
Soluble Blue, lb. powder	.75	@	.78
Sulphur, black, lb.	.60	@	.90
Sulphur, brown, lb.	.25	@	.50
Zinc dust, lb.	.22	@	.28
Zinc oxide, lb.	.12	@	.14
Zinc sulphate, lb.	.05½	@	.05¾

ESSENTIAL OILS.

Almond, bitter, lb.	14.00	@	16.00
Amber, rectified	1.50	@	1.60
Anise	1.07½	@	1.10
Camphor	.16	@	.20
Cinnamon, lb.	...	@	20.00
Clove, cans	1.65	@	1.70
Cubeb	5.25	@	5.50
Ginger	8.00	@	...
Limes, distilled	2.75	@	...
Pennyroyal, American	1.65	@	1.85
Peppermint, tin	2.20	@	2.30
Rose, natural, oz.	20.00	@	21.00
Wintergreen, synthetic, oz	.75	@	...
Wormwood, oz.	3.25	@	...

OILS.

Codliver, Newfoundland	.84	@	.86
Castor crystals, lb.	.23	@	...
Castor, "A.A."	.22	@	...
Castor, No. 3.	.21¾	@	...
Corn, crude	15.31	@	...
Corn, refined	16.76	@	16.91
Cocoanut, Ceylon	...	@	.18
Fusel, Haarlem	6.00	@	...
Menhaden, light	.82	@	.84
Menhaden, brown	.80	@	.82
Menhaden, winter	.84	@	.86
Menhaden, extra	.86	@	.88
Myrbane, drums	.19	@	.20
Myrbane, cans	.20	@	.21

COAL-TAR CHEMISTRY

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives.

Crudes, Intermediates.
Artificial and Natural Colors.
Synthetic Medicinals, Flavors, and Perfumes.
Explosives, Photographic Developers.

Edited by
Thomas H. Norton, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

Sidney Blumenthal, President, "The Shelton Looms," Shelton, Conn.

George H. Bruce, LL.B., Gold Leaf Manufacturing Co., New York.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hebden, Ph. D., Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co. Los Angeles.

H. Gardner McKerrow, of the Marden, Orth and Hastings Co., Inc., New York.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

I. F. Stone, Vice-President of the National Aniline & Chemical Company, Inc., New York.

Foreword

THE evolution of American technical chemistry has been characterized hitherto by a deplorable lack of symmetry, of coordination, of even and harmonious development. No country upon the face of the globe possesses in equal variety, and such vast quantity, the raw materials required in industrial chemistry. In no other country is the domestic demand so great. In certain fields American chemical talent and enterprise have shown marvelous powers of expansion and the ability to completely dominate the domestic situation, and even enter aggressively foreign markets. Notable examples are our metallurgical industries, the fertilizer industry, sulfur and sulfuric acid, electro-chemistry, the soda industry, the oils and fats, etc., etc.

In other fields there has existed for years an almost complete dependence upon chemical products of foreign origin. With folded arms we have watched the chemists of a few European lands manufacture a variety of wares—often from raw materials furnished by American forest, field or mine—and send them broadcast to the markets of the world. Among others, they have supplied the current needs of thousands of American industrial plants, requiring, in varying amounts, a large number of diverse chemicals.

Our economic fabric, our existing chemical industry, our inventors, our schools of science and technology, all connected directly or indirectly with applied chemistry, have suffered from this lack of a harmonious development of industrial chemistry upon American soil.

That admirable unity, symmetry and many-sidedness—or rather all-sidedness—which characterizes marvelously the German chemical industry, and constitutes the chief source of its power, has, during the past, been conspicuous by its absence in this country.

In no branch of chemical technology have we been so distressingly behind the age as in the manufacture of coal-tar compounds. The industry, with its multitudinous ramifications, seemed firmly established and buttressed in Germany. Its dominance of the world's markets was such that, with the exception of little Switzerland, no competing industry worthy of the name was able to maintain an existence in other lands. In England and France the struggle towards emancipation was more marked. In the United States there was little more than the semblance of a coal-tar chemical industry.

The abnormal conditions attendant upon the titanic struggle raging across the Atlantic have furnished to the lands hitherto dependent upon German chemicals an intense stimulus to found their own domestic coal-tar chemical industries, and, at the same time, have ensured the most favorable possible environment for the establishment, upon a permanent basis, of all the various phases of this, the most complicated of the globe's different branches of technical activity.

This movement has found its most complete expression in our own country. With a degree of rapidity never before witnessed in so short a period, an American coal-tar chemical industry has been founded, and is daily extending the amount of its output, the scope of its activity and the variety of its products.

We can practically fix the date when we shall manufacture in American works, from American coal tar, the great bulk of the more staple colors, medicinals, photographic chemicals, etc., which prior to 1915 came almost exclusively from German factories. We can even confidently look forward to a period, in the very early future, when we shall produce the host of minor modifications, required in small quantities, but still constituent parts of a self-contained industry, with the enrollment of which among genuine American products, our complete independence in this field shall be achieved.

Such an industry, of nation-wide extent, a magnificent national asset, offering a multitude of openings for American ingenuity, enterprise, inventive talent and scientific attainments, bound to make itself soon felt in our foreign export trade, furnishing indispensable materials for several million workmen in our textile and allied branches, has a legitimate right to possess its own organ.

Our fertilizer chemists, our rubber chemists, our leather chemists, those in electro-chemical, metallurgical, illuminating and similar industries, have their special organs.

It has quickly been recognized that those identified with coal-tar chemistry, as manufacturers of all its varied products, as dealers or as consumers, as supplying the mechanical accessories for the industry, should have at their service a publication devoted primarily to their combined interests.

The publishers of the CHEMICAL ENGINEER, after consultation with representatives of the various interests involved, have decided to devote the periodical chiefly to these varied interests. Its columns will be open to the free discussion of the many problems, technical, economic and fiscal, connected with the steady, healthful evolution of the industry, and the most advantageous and profitable uses of its products.

The division of synthetic colors will necessarily occupy the most space. In this connection, on account of the close relationship, full consideration will be devoted to the manufacture and utilization of natural dyes.

The ideal of the editorial management will be to offer a medium for the prompt and full publication of all progress made by American chemists in developing the manufacture and application of synthetic colors and other compounds derived from coal tar, and to place at their service exhaustive and complete résumés of all advances chronicled in other lands.

Ample assistance in this effort will be rendered by a Board of Associate Editors, representing effectively the various categories of interests enumerated.

No pains will be spared to render this new phase of the CHEMICAL ENGINEER'S activity thoroughly equal, and, if possible, distinctly superior, in point of variety, fullness, accuracy, illustrative features and collective exhibits of samples, to any of the European periodicals devoted to special divisions of its more comprehensive field.

THOMAS H. NORTON.

THE MERGER OF LEADING AMERICAN MANUFACTURERS OF COAL-TAR CRUDES, INTERMEDIATES AND COLORS

IN April of this year general interest was aroused by the announcement of the prospective merger of several of the leading factors in the American coal-tar chemical industry.

The details of this merger have been perfected since then. At the beginning of June the "National Aniline and Chemical Company" of West Nyack, N. Y., with a capital of $17,231,000, was incorporated by I. Frank Stone, William N. McIlravy and William Beckers.

The three leading constituents in this combination are the Schoellkopf Aniline & Chemical Works of Buffalo, the W. Beckers Aniline & Chemical Works of Brooklyn and the Benzol Products Company, having its main works at Marcus Hook, Pa. Another integral factor is the National Aniline & Chemical Company of New York, which has been the selling agency of the products of the Schoellkopf Aniline & Chemical Works of Buffalo. It has, however, conducted a large and successful trade in staple chemicals, and in this connection maintained a small factory on Long Island.

Furthermore the new organization includes certain interests and manufacturing features of three other powerful companies, the Barrett Co., the General Chemical Co. and the Semet Solvay Co. These constituent parts of the merger deserve individual description and analysis.

The Schoellkopf Aniline & Chemical Works is the oldest and most powerful of existing American producers of artificial colors. It was founded in 1879 at Buffalo. Amidst much of discouragement, struggling for years against unfavorable economic conditions it has endeavored in every possible way to build up a genuine American coal-tar color industry. Several synthetic dyes, of recognized value in the world's markets, were invented and first produced in its works. At the outbreak of the current war the company was manufacturing some 106 different artificial dyes, in varying amounts. Practically all of these products were made from intermediates of European origin. After 1914 the company was forced to depend largely upon intermediates of its own manufacture, supplemented, however, by aniline of American make. The variety of dyes produced was immediately cut down to less than a score. The list included staple colors of large consumption, most easily and rapidly manufactured.

Attention was devoted chiefly to the production, on a vast scale, of the black dyes, constituting about three-quarters of our normal consumption. During the past two years the variety of colors has again expanded. A large amount of capital has been invested, and the erection of new buildings with their subsequent mechanical equipment, has been upon the most generous scale. It is undoubtedly owing in great part to the unwearied and farsighted plans and efforts of this company that the pinch of our "dyestuff famine," at the close of 1915, was not felt more severely. Today it represents the largest aggregate of capital, experience and output in the domestic industry. It is, logically, the nucleus around which other factors in the industry would naturally crystallize.

The W. Beckers Aniline & Chemical Works, of Brooklyn, is of quite recent origin. Dr. Beckers, a graduate of the University of Heidelberg, and with broad experience in color chemistry, founded a modest factory in 1912, in which some 15 synthetic dyes were regularly produced prior to the war. He quickly grasped the possibilities of the situation early in 1915. Capital was enlisted, and a large, well-equipped color plant was swiftly erected. Today the buildings number about 40, the capital is $5,000,000 (about one-half of the presumed capitalization of the Schoellkopf company) ,and where one workman was employed in 1914, now 100 are busied. The Beckers works specialize on colors for wool, while cotton dyes predominate in the output of the Schoellkopf works.

Shortly before steps were taken to consummate the merger in question, the Beckers Aniline & Chemical Works notably increased the range of its operations by acquiring the Standard Aniline Products Co. This latter was organized in New York early in 1915. Its works at Wappinger's Falls and at Newburgh have attained considerable proportions. The output consisted at the beginning mainly of b-naphthol and p-nitraniline. Sulphur black and a few other staple colors were successively added, until the company finally became a factor of some importance in the dyestuff situation.

The Benzol Products Company came into existence late in 1910. It was organized by representatives of the Barrett Co., of the Semet Solvay Co., and of the General Chemical Co. These several companies felt that the time was ripe for establishing in this country the manufacture of aniline and possibly other coal-tar intermediates. The Barrett Co., which has done so much to build up an American coal-tar industry, was, then, the chief producer of benzene and other coal-tar crudes, in varying degrees of purity, derived from its numerous tar works. The Semet Solvay Co., actively engaged in the construction of coke ovens, and occasionally of benzol recovery plants, controlled, likewise, a certain supply of benzene, toluene and xylene, secured from the scrubbers of these plants. Finally the General Chemical Co. was in a position to supply the acids and other chemicals needed in the manufacture of aniline and allied compounds at an extremely low cost. It was felt, and quite correctly under existing conditions, that by a union of the interests, eliminating all unnecessary costs, American-made aniline was a practical proposition. And so it was. Bitter competition, however, on the part of European rivals, soon made its appearance. The price of aniline, in this country, descended rapidly. In 1914 the Benzol Products Co. was struggling to keep up its manufacture, with current rates below its cost of production. The war put an end to this attempt to throttle the young industry. The organization promptly recognized the possibilities before it. The plant has been multiplied many fold, and the company is now furnishing, in great amounts, a variety of the leading intermediates needed by the growing color industry.

The same reasoning, which lay at the basis of the foundation of the Benzol Products Co., in drawing together mutually interested factors, each capable of contributing an essential part, has lead to the vastly greater merger of the three constituents, enumerated above, in the National Aniline & Chemical Co.

The three parent organizations of the Benzol Products Co. are in a position to contribute, with equal advantage, to the new, comprehensive corporation. The Barrett Co. has multiplied its facilities for producing on the most ample scale, in a high state of purity, all the crudes required in the industry.

The Semet Solvay Co. has likewise multiplied its plants for furnishing the hydrocarbons coming within its purview. It has, in addition, embarked most successfully upon the manufacture of two important coal-tar derivatives, salicylic acid and sulphur black.

The General Chemical Co. can provide, with ease, all the many chemicals required in a comprehensive, self-contained color industry.

The newly formed organization is, therefore, distinctly in advance of the individual, large dyestuff plants of Germany. A very few, such as the famous "Badische" company, manufacture some of the leading chemicals needed and more or less of the intermediates employed.

None, as far as the writer is aware, control sources of crudes, or such a general supply of intermediates and of ancillary chemicals, as will be the case in the new American organization.

To all connected with our young coal-tar chemical industry, either as producers or consumers, and to not a few outside, this important consolidation gives rise to some most interesting questions of a combined economic, ethical, legal and patriotic nature.

Among them are the following:

Will this move towards consolidation progress, and to what extent?

Is it desirable in the interests of American consumers of artificial colors?

Will it aid or retard the evolution of a comprehensive, self-contained American color industry?

What will be the effect on our ability, under normal conditions, to meet foreign competition in the international markets for coal-tar products?

As far as the general desirability of consolidation is concerned, the writer is firmly convinced of the wisdom of the policy, and cannot do better than reproduce an expression of opinion, contained in an address before the New York Section of the Society of Chemical Industry, on October 22, 1915:

"There are several other phases in the evolution of an American color industry which deserve careful attention at the present time.

"The first is connected with the somewhat rapid entrance into this field of a number of separate interests, imperfectly acquainted with the complexity of the problem.

"It is well known to every one who has studied the fundamental basis of the past dominance of German color chemistry in the world's markets, that the chief cause of this marvelous control lies in the solidarity of the German industry as a whole. It is so organized that all the correlated parts act in unison. They form practically a unit when, in any land, a serious effort is exerted to secure freedom from dependence upon foreign sources of color.

"The question now arises, Is it not eminently desirable that a comprehensive American coal-tar industry, striving to supply nearly all American tinctorial needs, with products made from American raw materials, should possess a higher degree of unity—financial, technical, commercial—than now is the case? Is it not of prime importance that all unnecessary overlapping and duplicating of effort be excluded, at least in the formative stage?

"The problem is more easily stated than solved. It is economically important, during the initial period, that the industry should be characterized by that unity and solidarity which contribute so largely to the might and effectiveness of the German rival; and yet it must be free from any tendency toward monopolistic power.

"For the moment it suffices to express an aspiration, a hope, for economic conditions which may powerfully aid a young industry in bravely holding its own."

Since the date, abovementioned, the power and strength of the German coal-tar chemical industry has been mightily heightened. The leading factors, acting ordinarily in unison upon matters concerning the export trade, entered, a year ago, into a formal organization with a high capitalization, for the distinct purpose of winning back, and holding the markets of foreign lands, where determined efforts were being made to create domestic color industries. This move was actuated largely by the rapidity with which capital and enterprise were building up an American rival.

The aims of this organization are to bring about the closest correlation between all phases of the coal-tar chemical industry, so as to eliminate every unnecessary item of cost, as soon as the old-time activity is resumed; and, furthermore, to conduct most energetic and determined campaigns in countries, such as the United States, in order to recover the former supremacy.

This attitude on the part of the giant rival across the Atlantic might have caused more serious apprehension among those connected with the upbuilding of the young American industry, familiar, as some of them are, from personal experience, with the weapons likely to be employed, were it not for the statutory provisions against unfair competition, on the part of foreign manufacturers and importers, contained in the Federal enactments of September 8, 1916.

Even with the danger of deliberate, prolonged underselling, below the cost of production, eliminated from prospective commercial warfare, there is not the slightest question but that our American manufacturers of synthetic colors will be put upon their mettle when the day arrives for the great factories on the Rhine and the Spree to ship their products freely to this side of the Atlantic.

There will be a powerful combination of lengthy experience in salesmanship, of friendly relations with consumers, of well-equipped laboratories, of offerings of colors not yet produced in American works, as an inducement to exclusive trade, and all the other devices at the service of a long-established import trade. The protection of a fairly adequate, although unevenly constructed, tariff may not suffice to ensure a successful outcome in the contest.

The American industry must resort to the same class of weapons as those employed by the European rival. Of these the chief one is *consolidation*.

It does not necessarily imply a disappearance of name and individuality on the part of constituent members. There is no plan for this in the big American merger under consideration. It does, however, mean the complete cessation of all duplication of effort, scientific, technical and commercial. A single selling organization suffices for the entire series of productive factors. Free consultation between the respective chemical staffs will prevent overlapping in plans or in production, and will lead to a healthful cooperation, whereby each can profit from the criticism and suggestions of professional colleagues.

The result will be that costs of production can be steadily lowered, that standards of purity and uniformity can be continually raised, that the varying needs of the thousands of consumers of tinctorial wares can be met more easily, adequately and satisfactorily.

There will be the *élan* and *esprit* of an army, well-officered, under capable leadership, rather than the guerrilla warfare of scattered bands.

Viewed in this light there can be little doubt that the consolidation of our coal-tar chemical interests on an intelligent, generous, patriotic basis, provides the most effective defense against the possibilities of bitter, even vindictive onslaughts by foreign rivals at no remote date; and, furthermore, that it furnishes our strongest insurance for an economical, well-balanced evolution of the domestic industry. It will mean perfect coordination and correlation at every stage of the growth; avoiding loss of by-products, meeting first the heavy demands for a comparatively small number of staple colors; then adding steadily the dyes consumed in limited amounts, but of great utility in numerous minor phases of industrial activity; finally dovetailing in all the coal-tar products of non-tinctorial value, medicinals, perfumes, developers, etc., until the American industry is complete in every sense of the word.

Logically and actually this ideal can be attained only by a combination of all existing factors. It is not known whether those included in the present merger plan to invite further additions to their number, or whether their attitude will be the reverse.

The facts in the case would all point to the wisdom of a course characterized by generosity and helpfulness, towards scores of minor enterprises in the broad field, and of cordial cooperation with a few more powerful factors. It would be the patriotic and genuinely American attitude to assume—in harmony with that deep current of feeling sweeping through the nation, as we send our youth in arms, and our loans of billions across the ocean.

A vast amount of the nation's capital has been invested in scores and scores of plants, scattered over our country, engaged now in the production of coal-tar intermediates and dyes. A multitude of men are gaining experience in all the various phases of the industry. An elastic policy of consolidation, affiliation or cooperation with these diverse units of a big national asset, on the part of an overshadowing, and to a certain extent, dominant factor, would have a broad economic bearing. It would insure a continued and profitable utilization of men, capital and plant.

As an industry becomes more and more perfected in methods and mechanism, centralization is inexorably the rule. Some years must inevitably pass before the tendency may be felt very strongly. In the meantime it would be of most pronounced value to the separate units, to the industry as a whole, and to the nation, if most existing elements could be brought into direct cooperation with the newly constituted organism.

Such unity and solidarity would be of incalculable value, as the industry expands and one color after another will be produced in amounts more than sufficient to meet domestic demands. If we sally forth into the world's markets we must meet the close competition of German wares, not only in quality but in price. If we are to succeed, the cost of production must be brought to the lowest possible point. Nothing will further the attainment of this end better than to retain in the industry every keen-witted enterprising man who has been enlisted during the emergency call of the past two years.

We have no surplus of experienced coal-tar chemists and coal-tar operatives to draw upon, as was the case in Germany—prior to the great war. We are slowly training the men who will be the brains for us scientifically and technically when we enter upon the struggle for foreign markets. Hence, let us carefully retain in the industry every human asset.

An artificial color represents the combined result of an enormous amount of most varied inventive and constructive ability. It falls into the same category as a watch, a typewriter, a machine tool, a locomotive. We can confidently look forward to an early date when our American color industry, thoroughly standardized, and perfected in every detail, will win a place in international trade, quite as secure as that of any of the articles cited, and scores in addition. But to accomplish this we must not neglect a single one of the many factors involved.

It may be urged that in the above considerations, not the slightest attention is paid to the laws of competition, and to the desirability of affording them free play in the evolution of the new industry. In reply it may be said that some time must elapse before a national, well-rounded coal-tar chemical industry can physically be evolved. During this period the absence of competition is the most desirable feature. It is owing to the fact that German competition is non-existent that the industry has gained its start. Under normal conditions, facing German competition of the keenest nature, modified by the restrictions of a tariff, destined more and more to reflect purely demonstrable differences in cost of production, the American consumer of dyes can rest assured that his legitimate interests will be protected, no matter whether there is a single, collective American organization for the production of synthetic colors, or a battalion of small units.

Dr. B. C. Hesse has aptly termed the coal-tar dyestuff industry "a one-nation industry," and raised the pertinent inquiry, whether on purely economic grounds it might not be better to leave the creators of the magnificently equipped and organized German color industry to the quiet enjoyment of well-earned rewards. There is much to be said on both sides of such a question. As a matter of fact, however, we finally have our American industry deep-rooted and bound soon to reach the point where it will fairly well meet the nation's tinctorial needs.

The question may here also be pertinently asked, whether it would not be economically advantageous for this country if a single, well-organized combination of existing and prospective factors controlled its coal-tar chemical interests. The proposition is warranted by the marvelous complexity of the industry, beyond that of any other phase of human activity, requiring logically the closest coordination between all of its multitudinous ramifications.

With the assurance of scientifically adjusted tariff rates, and the consequent check of watchful foreign competition there is much to lead to the conclusion that the principles upon which the recent merger is based, and the extension of its organization so as to include the remaining factors in the branch, will inure in the highest degree to the early and successful establishment of a comprehensive, self-contained American coal-tar chemical industry.

AMERICA'S CHEMICAL PROGRESS

By George H. Bruce, A.M., LL.B.

AND then, "The United States came into her own!" Nor will we find it necessary to await the cessation of the world's hostilities to make that a truism.

Overnight, almost, our industries seemed to be on the verge of chemical starvation. Manufacturing interests that required generations to build and millions to maintain, found that they had placidly drifted along, ordering and using foreign colors and chemicals, turning a deaf ear to the occasional venturesome individual who defied tradition and staked his all to offer something "Made in U. S. A.," that would answer the purpose of the foreign goods.

It would seem impossible to conceive a more hopeless, a more unprofitable, a more discouranging task, to undertake in the United States, prior to August, 1914, than to enter into the dye and chemical business. Not that we did not have some large plants that were successful; but considering that the field was a country of one hundred million people, and that industries involving millions and millions of dollars depended on foreign made goods for the greater part, our contribution was negligible.

The American is nothing if not a good philosopher. You can picture him saying in his matter-of-fact way, "Well, they must have goods and we must make them." So he proceeded to enter a field of industry that called for scientific knowledge, for vast capital, for much experiment and consequent waste, with the same nonchalance that he displays when he bores on the market, learns to dance, rides a horse or plays golf. "If it must be done, why worry over it and make the task so much more arduous?" Then the color and chemical works sprang up all over the country. Great coke plants began to recover the valuable benzol that had been used as fuel or wasted. And the chemists proceeded with their work of constructive independence. The libraries were filled. Chemical and industrial works of reference were in constant use. Gradually products were turned out. A few at first, but, Oh, Ye Gods! What some of those products were! "Nothing like them were ever before seen upon the earth, and in the heavens above the earth, nor in the waters under the earth!" We prayed and worked and pleaded, encouraged and scolded, but never a falter nor a surrender, and while all perhaps [illegible] and proceeded to one failure followed another and another experiment was sent down the sewer, and always was there a helping hand and a more experienced workman to straighten out kinks. Back of it all stood the departments of our Federal Government, especially the Bureau of Foreign and Domestic Commerce, with its talented, self-sacricing staff, co-operating and working with such zeal, such patience, such ability, that slowly but surely the infant industry grew to man's size, with a capital of many millions. Nor is that the most encouraging feature, but rather, that from nothing, and then chaos, have arisen solid, substantial industries, systematized as well in their business methods as in their products. The art of standardization has been acquired, waste is replaced by useful by-products; and—wonder of wonders!—consumers are not only buying domestic products willingly, but are actually converted.

It is within the writer's knowledge that some large consumers have refused the offer of foreign goods of the highest standard, and given out contracts for domestic wares, not, as they confess, out of patriotism, but solely because they found them better. Confessedly the most sanguine never dreamed of such a condition prevailing in less than three years. True, there is much yet to do, oh, so much; but as we view conditions in the retrospect we need have no fear for the future.

To those not "of the cloth," as it were, it is impossible to realize the little less than miracles that have been accomplished. Yes, they have produced the so-called impossible colors; they have even gone the foreign genius one better and proceeded to extract colors from autumn leaves and produce a commercially valuable dye.

Yes, it looked like a Herculean task which we had on hand; but, perhaps, like no other people, the American rises to an occasion. Whether it is to build a canal theretofore called impossible, an air ship that will fly or a color that apparently only a foreigner could make, he finds a way of "getting there" that is truly refreshing and delightful. All the time, while "getting there," he is standing your abuse, ridicule and scolding—much of which he deserves—without a word of complaint, because he knows he deserves it. But does that discourage him? Not much! He grits his teeth and says, "I will show them!" And he does. HE HAS! My hat is off to the American. This is, briefly, the progress of the chemical and color industries in the United States of America, and the future has even greater wonders to unfold.

COAL-TAR CHEMISTS TO ADVISE GOVERNMENT.

The Chemical Committee representing all phases of the chemical industry which has been organized for consultation and cooperation with the Council of National Defense and the Advisory Commission to dispose of all problems connected with the supply, conservation, distribution and production of chemicals and their combinations, includes the following names in the sub-committee on coal tar by-products and the synthetic phenol division:

Coal Tar By-Products.

William Hamlin Childs, chairman, The Barrett Company, 17 Battery Place, New York; J. A. Toppin, Republic Iron and Steel Company, New York City; H. H. S. Handy, Semet-Solvay Company, Syracuse, N. Y.; C. J. Ramsburg, H. Koppers Company, Pittsburgh, Pa.; W. H. Gartley, United Gas Improvement Company, Philadelphia, Pa.; W. A. Addies, Consolidated Gas Company, New York City, and Captain W. E. McKay, New England Coke and Gas Company, Boston, Mass.

Synthetic Phenol Division.

H. H. Dow, Dow Chemical Company, Midland, Mich.; W. A. Bradford, Butterworth-Judson Company, New York, N. Y., and Captain McKay.

II

COAL-TAR CRUDES

STANDARDIZATION OF BENZOL TESTS IN COKE WORKS

IN British coke plants there is a wide diversity among the methods employed to test the efficiency of the benzol scrubbers. The Miller test, so largly used in Germany, is chiefly in vogue.

T. B. Smith, in a recent address before the Coke Oven Managers' Association, at Darlington, recommended strongly the following mechanical method: Creosote oil is used as an absorbent in preference to oleic acid, or nitrobenzene. The fraction boiling between 240° and 270° is thoroughly washed with acid and soda in order to remove tar acids, pyridine bases, etc. It is then allowed to stand upon ice until the naphthalene present is frozen out. This purified absorbent is introduced into a series of four bottles of 100 c.c. capacity, and of a type offering a maximum surface of contact.

The gas to be tested, after passing through drying towers, is conducted through the absorption train—each bottle being surrounded by ice—to the meter at the rate of 8 to 10 liters per hour. After 100 liters have passed the apparatus is disconnected, and the absorbent is distilled until 50 c.c. are collected, this, in turn, is redistilled, and the distillate, up to 160°, is collected and measured. A parallel experiment is made with 50 c.c. of the crude benzol of the day's run, and the quantity distilling to 160° is measured. These results furnish the data for a simple calculation. For example, if the absorbent yielded 3 c.c. of distillate passing below 160°, and 50 c.c. of the crude benzol of the day's run yielded 37.5 c.c. up to the same temperature, then the 100 liters of gas passing through the absorbent must have surrendered 4 c.c. of crude benzol.

This short and easy method gives results in close accord with those obtained by the more lengthy Müller test.

An almost as accurate chemical method employed by Smith is the following: 100 liters of coke-oven gas are passed through an acid absorption system at the rate of 10 liters per hour. The apparatus consists of 4 bottles and a final U-tube containing calcium chloride. In bottles Nos. 1 and 2 is a mixture of nitric and sulphuric acids in the proportions of 70 per cent. sulphuric to 30 per cent. nitric. No. 3 contains distilled water, and No. 4 approximately twice-normal NaOH solution.

All aromatic hydrocarbons passing through the apparatus are nitrated, the products collecting in a supernatant layer, floating at the top of the acid in bottle No. 1. The nitric fumes evolved are all absorbed in bottles Nos. 2 and 3. The gain in weight of the entire absorption apparatus gives the quantity of aromatic hydrocarbons in 100 liters of gas.

Monthly tests of the amount of gas evolved with carbonization of a ton of coal are advised. Many chemists base their calculations on the general statement that a long ton of coal yields 10,000 cu. ft. of gas. There are, however, in practice, wide divergencies from this figure, depending upon the class of coal used, and notably upon the temperature of carbonization.

In these days, when the demand for benzene, and especially for toluene, is so urgent, it is found desirable to neglect no precaution in insuring a maximum recovery of the hydrocarbons present in coke-oven gas.

Receivers of Aetna Explosives Co. Secure Privilege to Fulfil Contract.

The receivers of the Aetna Explosives Company have been authorized by the courts to enter into a contract with the Pittsburgh By-Product Coke Company for the purchase of a quantity of toluene at $1.35 per gallon, solvent naphtha at 13 cents per gallon, and benzene at 45 cents per gallon. The purpose of granting this privilege was to enable the receivers to deliver to the French Government 1,000,000 pounds of "T. N. T." per month, as per contract.

Explosion in Barrett Co. Plant.

A recent explosion in the naphthalene building of the Barrett Manufacturing Company's chemical plant Frankford, Pa., completely destroyed the building and started a conflagration which burned portions of several others, causing a total loss of $40,000. Officials of the company say that the fire was caused by a tank overflowing and the contents coming in contact with a stove. It was believed that operations could be resumed within a few days.

Lines of Advance in Coking Practice.

In an address before the Yorkshire section of the Society of Chemical Industry, G. E. Foxwell advocated earnestly the desirability of shortening the carbonizing period in order to increase the output. He advises the recovery of benzol of much lower strength than is now the rule, the product to be washed for phenol. He claims that by aiming at a benzol of 55 per cent., instead of 65 per cent, as at present, there is a marked increase in the amount of toluene recovered.

Mr. Foxwell urges strongly the establishment, at coking centers, of the necessary plants for refining the hydrocarbons, and for producing from them many of the simple intermediates, such as aniline, the toluidines, etc.

It is worthy of note, in this connection, that such a policy has already been adopted by several American coking companies.

The American Tar Product Company will erect at Woodward, Ala., an addition for the manufacture of naphthalene.

III

COAL-TAR INTERMEDIATES

A CYCLIC PROCESS FOR THE MANUFACTURE OF PHENOLS

Professor Louis M. Dennis, of Cornell University, has recently (Amer. Pat. 1,227,894, of May 29, 1917), devised a cyclic method for the manufacture of phenols from aromatic hydrocarbons, which claims distinct economic advantages over current processes.

The following is a description of the sequence of operations for transforming benzene into phenol. It is naturally, applicable to the production of a large number of the hydroxyl derivatives of aromatic hydrocarbons:

"Benzene is treated with sulfuric acid, preferably fuming sulfuric acid, to produce benzene-sulfonic acid in excess of sulfuric acid. This mixture is treated with benzene. As the sulfuric acid is practically insoluble in benzene, the latter takes up the benzene-sulfonic acid, but not sulfuric acid to any appreciable extent, forming a benzene solution of benzene-sulfonic acid, substantially free from sulfuric acid. This benzene solution of benzene-sulfonic acid is treated with water, which dissolves out the benzene-sulfonic acid and separates the same from the benzene.

"In order to initiate the process and to produce the initial charge of sodium benzene sulfonate, the aqueous solution of benzene-sulfonic acid, substantially free from sulfuric acid is treated with an aqueous solution of sodium hydroxide, or other suitable sodium compound, to form sodium benzene-sulfonate. This is separated from the solution, dried, and fused with solid sodium hydroxide, forming sodium phenolate together with sodium sulfite. The sodium phenolate is then treated with an aqueous solution of benzene-sulfonic acid, substantially free from sulfuric acid, forming phenol and sodium benzene-sulfonate, which may be separated by suitable means. The solution of sodium benzene-sulfonate is then evaporated to dryness and the dry sodium benzene-sulfonate then fused with solid sodium hydroxide, forming as before sodium phenolate and sodium sulfite. The sodium phenolate is then neutralized with a fresh charge of benzene-sulfonic acid, substantially free from sulfuric acid, forming as before, phenol and sodium benzene-sulfonate, and the process repeated. The sodium sulfite which is formed in the process is removed from time to time as may be necessary.

The reactions may be illustrated substantially as follows:—

$$C_6H_5SO_3Na + 2NaOH\ (\text{fused}) = C_6H_5ONa + Na_2SO_3 + H_2O$$

$$C_6H_5ONa + C_6H_5SO_3H = C_6H_5OH + C_6H_5SO_3Na$$

$$C_6H_5SO_3Na + 2NaOH\ (\text{fused}) = C_6H_5ONa + Na_2SO_3 + H_2O$$

ELECTROLYTIC PRODUCTION OF COAL-TAR INTERMEDIATES

The Society of Chemical Industry in Basel has worked out in a recent patent (Br. Pat. 15,750, Nov. 8, 1915) a practical method for effecting the oxidation or reduction of certain aromatic compounds, which are insoluble in the electrolyte. An essential feature is to have just enough difference between the specific gravity of the electrolyte, and that of the compound to undergo change or its solution in liquid which does not mix with the electrolyte, so that adequate emulsification is allowed in the immediate neighborhood of the active electrode. No diaphraghm is employed, and there is no wandering of the compound, undergoing treatment, to the other electrode.

In the case of the reduction of nitrobenzene to azobenzene, a vessel of sheet iron is employed, which widens downward to a funnel-shaped bottom lined with cement. This tank serves as an anode. The cathode consist of a cylindrical roll of layers of wire gauze. A hot mixture of caustic soda solution and nitrobenzene is kept in constant circulation through the meshes of the cathode by means of a high-speed rotary pump. The emulsion collects in the bottom of the tank

In converting azobenzene into hydrazobenzene, a cement tank is employed. It is charged with hot caustic soda solution, containing PbO. A solution of azobenzene in benzene floats on top. A flat electrode is suspended near the top of the liquid. A similar anode is at the bottom. Oscillation of the cathode causes emulsification. The oxygen, evolved at the anode, is led off by a wire sieve.

In the production of hydrobenzene from nitrobenzene, a similar ararngement is used, the position of the electrodes being reversed. The electrolyte consists of PbO and caustic soda. A heavy substance, such as dichloro-naphthalene, is mixed with the nitrobenzene.

A similar device is employed for the transformation of o-nitrotoluene to hydrazotoluene. Agitation of the solution below the cathode is effected by means of an external rotary pump.

In the operations described, PbO may be replaced by SnO or by ZnO. The reaction is under constant control. It can be interrupted with the transformation into an azo compound, or it can be prolonged into the hydrazo stage.

The Manufacture of Sulfonic Acids.

D. Tyrer (Br. Pat. 103,204; Jan. 12, 1916) prepares the monosulfonic acids of benzene and other hydrocarbons, boiling below 200°, by passing the vapor of the hydrocarbon through H_2SO_4 heated to 100°. By this method the H_2O formed is steadily removed from the reaction mass. In the preparation of disulfonic acids, the current of vapor is stopped when a given amount of the monosulfonic has been formed. More H_2SO_4 is added and the temperature is raised to the favorable point. It is noted that the unsulfonated portion of a hydrocarbon, treated by this method, has been freed from its impurities, notably from sulfur compounds, and can be condensed in a purified form.

IV

ARTIFICIAL COLORS

THE MANUFACTURE OF COAL-TAR COLORS IN ENGLAND

[The experiences of Great Britain in facing a dyestuff famine and how it was met are parallel in many respects to those through which the United States has passed. Yet, in certain connections there are distinct differences. The tale of these experiences, as recently given in the London Times, is at once interesting and instructive. The author of the first section is a prominent member of the staff of British Dyes (Limited). The author of the second section is anonymous.—Ed.]

I—POSITION ON THE OUTBREAK OF WAR

By C. M. Whittaker, B.Sc.

The coal-tar color position on the outbreak of war in August, 1914, may be very briefly stated by giving the Board of Trade returns of the imports of dyestuffs into Great Britain for the year 1913. They are as follows:

	Lbs.	Values
Aniline colors	31,699,024	$7,512,194
Alizarine colors	6,811,056	1,325,833
Indigotine	2,675,568	373,504
Indigo	467,488	266,578
Total	41,653,136	$9,478,110

It has been freely stated that business totaling annually $1,000,000,000, employing some 1,500,000 people, depended upon the above supply of dyestuffs. Of the above total imports, it was estimated that $9,000,000 was received from Germany; the balance was chiefly from Switzerland, except for a negligible import from France.

The number of qualified coal-tar color chemists in Great Britain was extremely limited, and the supply could not be extended without a considerable lapse of time.

British-Made Intermediates.

However, given the requisite labor and raw materials, there was a distinct nucleus upon which to commence building a national industry. Many of the important parent and intermediate products were being produced in Great Britain; both the plant and manufacturing experience were immediately available, though naturally not on the scale to meet the suddenly increased demand, due to the stoppage of the German supplies. The following list includes some of the most important:

Nitro-benzene: starting point for benzidine base, nigrosine, and induline.

Aniline oil: used for production of aniline black on the cotton fibre and with innumerable uses in color manufacture, including that of synthetic indigo.

Di-methyl-aniline: indispensable for basic colors, gallocyanines &c.

Para-nitro-toluene: for direct cotton yellows.

Para-nitraniline: for para-red (Turkey red substitute), and direct cotton colors.

Meta-nitraniline: for mordant yellow for wool khaki.

Di-nitro-chloro-benzene: indispensable for sulphur blacks.

Di-nitro-phenol: indispensable for sulphur blacks.

Meta-phenylene-diamine: for sulphur browns, direct cotton blacks and browns.

Alpha-naphthylamine: indispensable for acid and fast chrome blacks.

Sodium-naphthionate: for direct cotton and wool reds.

Anthraquinone: parent product for alizarin and vat colors.

Imported Intermediates.

On the other hand there were many products, of the greatest importance, which were not being made in Great Britain on the outbreak of the war:

Alpha and beta-naphthol: these two products had been made in Great Britain, but their manufacture had been dropped.

Beta-naphthylamine: used for bright blues and mordant yellows.

Di-anisidine: for bright sky blues.

Benzyl chloride: for acid violets.

Benzaldehyde: for malachite green and patent blues.

Anthrarufine: for fast to light wool blues.

Phthalic anhydride: for rhodamines, etc.

Salicylic acid: for mordant and direct cotton colors.

Representative members of every class of dyestuffs were being made in Great Britain with the exception of vat colors, but there were many gaps. Among the most important colors, apart from the vat colors, not being made in Great Britain by British firms the following must be named:

Alizarin blues (other than blue S), greens, and blacks.

Alizarin sapphirole and its allied colors.

Patent blues so largely used by the shoddy trade.

Direct cotton colors of outstanding fastness to light.

As a set-off against these it may be said that the British makers were very strong in sulphur colors, which are of so much importance in cotton dyeing, basic colors, acid colors and, fortunately, those mordant colors which were required for dyeing the wool for the khaki uniforms

In conclusion it may be repeated that the most serious factor in the color situation, on the outbreak of war, was the paucity of color chemists with actual experience in the manufacture of dyestuffs, a factor which only time can remedy.

It must not, however, be thought that all the above color was consumed in Great Britain, because a considerable quantity of color has always been brought to this country for shipment to the various mills in India, Australasia, and South America To the above must be added the production of the British makers, which was estimated to be worth approximately $1,000,000 or 10 per cent of the total imports

Recovery in England.

It is a mistake to assume that there was no coal-tar color industry in Great Britain All the world now knows that Great Britain started the coal-tar color industry, but that the industry gradually declined for reasons, which do not fall within the scope of this article, till it had reached its lowest ebb in the years 1898-1900. What is not, however, generally known is that from the latter date there was a gradual revival of the British industry, due to enlightened management, so that one British firm was in a position to pay 10 per cent. for several years prior to the war.

The following firms were engaged in coal-tar color manufacture in Great Britain in 1914:

The British Alizarin Company, Silvertown, E. This company was started by large users of alizarin red in Great Britain to fight the German Alizarin Convention. It was successful in its efforts, but confined its production to alizarin red, alizarin orange, and alizarin blue.

Levinstein (Limited), Blackley, Manchester.

Read Holliday and Sons (Limited), Huddersfield.

The majority of the shares in these last two companies were held by the respective families.

The above three firms were the largest British-owned concerns, and there were in addition some smaller concerns, such as Claus and Co., Clayton, Manchester, and Morris, Denton, which confined themselves to a very limited range of products.

Foreign Firms in England.

In addition to the above there were the following three works in Great Britain, but owned by Continental firms, viz:

The Clayton Aniline Company (Limited), Clayton, Manchester, which is owned by the Society of Chemical Industry, Basle.

The Ellesmere Port Works, Cheshire, which were owned by Meister, Lucius, and Brüning, Höchst on the Main; synthetic indigo was manufactured here.

The Mersey Chemical Works, Bromborough, Cheshire, were owned by the German combine of the Badische Company, the Bayer Company, and the Berlin Aniline Company. These works were largely used for storage purposes. Sodium hydro-sulphite was manufactured, but large quantities of color were not made at these factories.

The weakest point in the British position on the outbreak of war was:

The British firms had been in the habit of buying so many of the important intermediate products from the Continent.

II PROGRESS IN BRITISH DYE MAKING

[Anonymous]

Nine months ago, in the London Times, under the title "Peril of British Dye Industry—Vigorous Action Essential," not only was the situation of this branch of chemical industry fully considered, but the discussion was extended in subsequent articles to the broader problems involved in the utilization of our coal, particular stress being laid upon the conservation of the by-products obtained in coking coal, as these are the raw materials from which dyestuffs are produced.

Over and over again, during the period of the war, various writers conversant with the requirements have urged that unless wise Government action were taken without delay it would be impossible to effect the complete organization of our dye industry so that it may meet German and other rivalry in the future. What is far more important, the users of dyestuffs generally have been consistent advocates of such a policy.

Mr. Sharp, the chairman of the Bradford Dyers' Association, in his recent address to the shareholders, in once more calling attention to the urgency of our situation could only lament that, notwithstanding the insistent and persistent appeals of the accredited representatives of practically all the color users in Great Britain and Ireland, the necessary steps had not been taken to secure the consolidation of the manufacturing interests in a single company so as to prevent overlapping and waste of effort. Yet, owing to the increase in wealth of the United States, Japan, and Holland the competitive powers of these countries have been greatly increased. France also will wish to take a larger share; so that the task before us will be a far harder one than it ever has been or was supposed to be a year ago.

After-War Measures.

Aware of our determination, if possible, to be masters in our own house, Germany will leave no stone unturned to regain possession of the markets of the world; and it will only be by utilizing the technical forces of the country in the most effective and economical manner possible that we shall be able eventually to make a position for ourselves; hence the imperative need of organization.

Mr. Sharp sees clearly enough that immediately the war is over we must be able to offer the widest range of colors, but he does not seem to have realized what this entails. He gives illustrations showing what certain firms have done, from which he argues, optimistically, that there are no insuperable difficulties in covering the whole field of German production. Unfortunately, the production of a wide range of colors must be a task of the greatest difficulty, on account of the large number and variety of the materials to be produced, each entailing for its manufacture not one, but probably a whole series of processes.

In point of fact the situation is an altogether peculiar one, and its gravity may easily be underestimated. During the early period of the war the critical position in which we were placed was not at first apparent to consumers. While some looked for the speedy termination of hostilities, others argued that the prolongation of war would cause a general paralysis of all the industries in which dyestuffs play a part. At that time considerable stocks were held by the representatives in this country of the German manufacturers—probably a six months' supply.

When these stocks appeared to be exhausted and the end of the war came to be looked upon as remote, the demand for dyes did not fall off to anything like the extent anticipated, and a period of panic ensued. Even the more easily produced dyestuffs—certain acid reds, oranges, and yellows—were rushed up to 30 or 40 times their pre-war value. British Dyes (Limited) came into being during this period, as a new State-aided enterprise unconnected with the other firms then in existence.

Present Conditions.

About this time useful agreements were made with the Swiss color manufacturers, which led to raw materials and intermediate products being exported to Switzerland and returned as finished dyestuffs. The effect of this action and of the progress made by British makers was to render the position easier, and of late far less anxiety has been shown.

Although prices still rule very high, most of the color-using industries of the country have been able to adapt themselves to the altered conditions. The reasons why the prophecies of the pessimists have not been fulfilled are various. Recent events are an indication that even now some of the stocks referred to are not exhausted, as dyestuffs, perhaps purchased at the winding-up sales of German firms, are from time to time still being put upon the market. The very low prices prevailing before the war, and perhaps in some cases carelessness in regulating purchases, had led not a few to buy considerably in excess of their immediate requirements. Such hoarded supplies, in conjunction with the restricted volume of trade, have provided dyers with a surplus which they have either used themselves or exchanged with other consumers. Then some of the German vessels captured early in the war had dyestuffs on board, and several hundred tons obtained in this way have been brought to this country and sold by tender.

During the past 12 months supplies have been sent from Switzerland with fair regularity; a few consignments have also reached us from the United States. Consumers, too, have learned to help themselves in various new ways. Not only are old stocks previously considered almost valueless made use of, but economies are being effected by using old dye baths for further lots of material to a greater extent than before, and dyeing methods are being modified with a view to the more complete exhaustion of the dye bath. Where the requisite experience is available, dyers are often reverting to older processes and substituting for coal-tar dyestuffs the more readily procurable vegetable coloring matters. Two notable instances are those afforded by the increased consumption of natural indigo and the more extended use of logwood and its preparations for dyeing blacks.

Consequently, there has been no absolute dyestuff "famine." It has been possible, with a few exceptions, to dye any given material to a shade at least near to that required; the resulting color, however, frequently lacks some property which would have been considered essential in pre-war days, such as fastness to light, washing, or acids, or brilliancy or retention of tone in artificial light.

Quality of Dyes.

But the range of dyestuffs now available unfortunately lacks many of those which possessed the highest degree of fastness. Thus logwood blacks on wool are inferior in fastness, on exposure to light, to many of the coal-tar blacks in use before the war; very few of the alizarin dyestuffs, so largely used for the production of fast colors on woolen material and also of the highest importance in the calico-printing industry, are now obtainable, and those that are can be had only in very limited quantities.

On the other hand, although it must be admitted that the colors of most dyed materials are now less fast than formerly, one important exception is to be noted. The direct black dyes used for cotton have been largely superseded by the sulphur blacks, which withstand washing and exposure to light much better. The necessary intermediate materials for the preparation of these having been available in larger quantities it has been possible to produce them much more cheaply than formerly.

Until recently, with the exception of a limited range of Swiss colors, we have also been without supplies of the "vat dyestuffs," a class which (owing to their exceptional fastness in light and on washing) had come into great favor in the days just before the war.

An interesting proof that enterprise is not altogether lacking in the industry is afforded by the fact that one dyer has even gone so far as himself to undertake, and with complete success, to manufacture one or more of these vat dyestuffs for his own use. These dyes have been placed at the disposal of the industry only during the past few weeks, but already two of the British dye manufacturers are advertising their sale competitively—a foretaste of the manner in which our firms will support each other in developing their industry if it remain unorganized!

It thus appears that, though we have helped ourselves to some extent, we have been far better provided with German dyestuffs than is commonly supposed; it is difficult to say what the position would have been without these supplies.

Future Conditions.

Probably we shall be able to struggle on during the period of the war fairly well with the aid of the present limited supplies of coal-tar colors, aided by various substitutes and makeshifts. But are we to revert to the old conditions afterwards? Even if, as a nation, we are prepared to sink into dowdiness, our textile and other dye-using industries must have a full range of the highest classes of dyestuff, and unless we can obtain similar materials, either from our own manufacturers or from abroad, at least our export trade must suffer most severely. It is clear that if we cannot revert to the old conditions we must learn to help ourselves much more than we are now doing.

No better evidence of the demand that will arise in the future could be asked for than is afforded by recent sales. A direct blue dyestuff, known to yield a very pure shade of sky blue on cotton, was sold at nearly $34 per pound. A concentrated brand of a bright pink Rhodamine is worth nearly $48 per pound. These dyestuffs could have been bought for about 60 cents and 96 cents per pound respectively before the war. As soon as war is over dyers will not only be called upon, but they will naturally strive to recover their efficiency and meet all requirements; the demand for novelties will once more assert itself.

Marked as has been the progress of several of the British firms during the past year or so, evidence is before the public that there is much unnecessary overlapping; those who are more or less behind the scenes know that the energies of manufacturers are being wasted in many directions owing to the entire lack of co-ordination in the industry.

Thus two competing firms have devoted capital and much scientific-skill to the production of the vat dyestuff of the indanthrene class already mentioned. A coloring matter of only secondary importance, methylene blue is being offered by five distinct firms, two British and three Swiss.

We know that the German makers have combined all their forces with a view to economy and efficiency in all branches of their work, including the interchange of intermediate raw materials. Here in recent times difficulties have been placed by one firm in the way of another, and much of the effort needed to build up a comprehensive and extended industry is being wasted in unnecessary repetition.

But there are other directions in which British dye manufacturers have to make up much leeway, in which there should be cooperative action. The German firms have, at all times, sought to aid the dyers and to secure their sympathy as well as their custom—they have sought to deserve custom by rendering all possible assistance to buyers.

Necessary Reforms.

The rendering of expert assistance of this kind should be made a stronger feature of the British color industry. Colors now being made are not identical with those which will be supplied after the war, but help given now, to the extent permitted by a reduced staff, will be amply repaid in the future. A firm grows accustomed to turning to a definite quarter when in difficulties.

The consumer must also help the manufacturer. This theme is merely the converse of the last. All information which the consumers can give to the manufacturer with respect to his methods and difficulties is of service in the search after improved products. Color users can also render great assistance by permitting trials with new dyestuffs on a practical scale to be made in their works.

In future, too, our color-makers must not rest content with mere imitations of the German dyestuffs previously in use, but must continually try to improve upon their foreign competitors; the possibility of success in this direction will depend, of course, largely on the presence in the works of the right kind of chemists with the right kind of training.

Dyers must contemplate during the first few years some slight financial sacrifice, though in hundreds of cases the actual cost of the dyestuffs is but a fractional percentage of the value of a finished article. In every case the use of a British dyestuff, even at a few cents more per pound while the color industry is being established here, may be considered but as the payment of a very low premium, indeed, on a policy which will eventually ensure us against a recurrence of the present ruinous conditions.

The Chairman of the Bradford Dyers' Association in his speech. expressed his confidence in British chemists, and there is no reason to doubt their ability to solve all the problems of the industry—given sufficient time. But there are not nearly enough of them for the work, which is of very special difficulty in its higher branches—not a tithe of the necessary number. The men who can develop such an industry are of an unusual type, born and not to be easily picked out; they are destroyed rather than developed by our system of education. To introduce foreign workers would be a fatal blunder and a grave discouragement to our schools.

Past Errors.

Unfortunately, too little has been done during the war to make efficient use of the more skilful among our chemists in developing our national efficiency as chemical manufacturers. Far too many have been set to work as laboratory hacks to make pharmaceutical preparations on a Lilliputian manufacturing scale. The proper course would have been to have allowed each of the more competent to build up gradually the nucleus of an industrial manufacture of some particular article. instead of a number all doing more or less the same thing.

In this direction. as in many others. we have gone astray through our failure to apply scientific method to our affairs and to organize our efforts.

It is easy to complain that Government has been short-sighted and will not take advice, but reflection shows that it could not well have been otherwise, in view of the general ignorance of every detail of the problem. What we have to complain of is the blank impassiveness of the official mind which leads it to put aside all advice—to pay no regard whatever to expert opinion.

But the beam in the scientific eye must not be overlooked. Far worse, than any failure of the Government is the failure of the representatives of science to organize themselves so effectively that whatever advice they might have tendered would have been so weighty that it could not have been put aside.

The question now is: Are we to the bitter end to court the failure we have so long invited? Mr Sharp spoke out very plainly in saying that he and his colleagues, in common with other color users held most strongly that the Government should by some means compel British color-makers to coordinate their efforts, and that we shall not attain the object we have in view unless the only step which can bring us to it be taken. No one who understands the situation can hold any other opinion, but the co-ordination must be far-reaching and complete.

GROWTH OF THE COAL-TAR COLOR INDUSTRY IN OTHER LANDS

A World-Wide Attempt to Secure Emancipation From German Sources.

[The following review, in the London Times for April 15, 1917, of the progress being made in other European countries. and in Japan, to ensure independence in the supply of artificial dyestuffs, shows how general and determined is the conviction abroad that it is an economic sin to allow a nation's textile and allied industries to be chained to a single source of the vital factor of color. —Ed.]

German artificial-color makers confidently predicted that their huge output of high explosives would bring about the early collapse of France and Russia, and that the lack of German dyestuffs would lead to the stoppage of the British textile industry and prove one of the factors that would force England to a humiliating peace. In any event these predictions are already falsified, and one of the results of the war will be the enfranchisement of the textile world from too complete dependence on Germany for artificial dyestuffs. There is a world-wide effort to establish the coal-tar color industry locally, and a potent factor for the success of the endeavor in each country is that the close relationship between color making and the manufacture of high explosives is as last fully recognized.

Switzerland.

Switzerland, next to Germany, is the largest producer of artificial colors. She was largely dependent upon the Fatherland for the raw materials of the industry and supplies were quickly stopped. With the aid of France and England this difficulty has been overcome, and although the Swiss Army is mobilized. and in consequence there is a shortage of labor. Switzerland is now sending out satisfactory quantities of dyestuffs, including some of the modern and very fast colors known as the vat dyes. As opportunity offers it is certain that the Basel works will be greatly developed, and it is probable that Swiss progress will be ensured by an entente with the British and French manufacturers.

France.

France had only one native artificial color works at the commencement of hostilities, the Société des Matières Colorantes de St. Denis. The Compagnie Parisienne de Couleurs d'Aniline at Creil and the Manufacture Lyonnaise de Matières Colorantes at Lyons, in spite of their Gallic names, are branches of German works, both still operating under government control. The St. Denis works, asociated with the name of Alcide Poirrier, who died recently, has had a long and honorable career. Poirrier almost immediately followed up Perkin's discovery and commenced the manufacture of coal-tar colors. Many important new colors were discovered at St. Denis, among others the highly important sulphur black. In spite of the difficulties of the times, the St. Denis works has modernized its plant, and important extensions are contemplatd.

Our Government support of British Dyes (Limited) has led to a similar movement in France. The Société Nationale des Matières Colorantes has been formed with a capital of 40 million francs, a syndicate with government support guaranteeing one million francs. The society will instal at its own cost in the Oissel Powder Works and other state explosive factories the plant necessary for the manufacture of the chemical and coloring matters required by the French industries, and for the explosives, chemicals or colors required by the Ministries of War and of Commerce. The society will deposit 500,000 francs in French securities with the Bank of France as a guarantee. The duration of the concession granted to the society is 18 years, and it is at liberty to relinquish it after 12 years. By the terms of its contract the society engages, as far as possible, to make all the chemicals and coloring matters required by the French textile industries. It is understood that certain arrangements have been made between this French National Company and British Dyes (Limited), probably as regards the provision of raw material and to avoid overlapping.

Another new company, with a capital of three million francs, is the Compagnie Française des Produits Chimiques et Matières Colorantes de Saint Clair du Rhône. As a director of the National Company is on the board, it is surmised that there is an entente.

Italy.

In Italy matters are less advanced, but the Italian National Dyestuff Company has been founded with a capital of six million lire ($1,154,000). The most important Italian financiers and the heads of the chemical industry have assisted. The value of the annual importation of German chemicals into Italy has been 30 million lire ($5,790,000).

Japan.

Japan is now independent of foreign supply in the important items of aniline oil and salt. The dyestuff industry has been fostered since the outbreak of the war; the total value of dyes annually imported into Japan previously amounted to $4,000,000. The Tokyo Gas Company, the Mitsui Mining Company, and a few others have succeeded in manufacturing artificial dyes successfully, and are learning rapidly. Sulphur dyes, including black and browns, are not yet fully perfected, but their production has been fairly large. The Japan Dyestuff Company, which was launched some time ago under official protection, will also start the manufacture of some special description of dyes at its own factories, which are now being completed.

Russia.

Russia made an early attempt to organize a dyestuff industry. Some progress has been realized, and arrangements have been made to engage chemists from the friendly countries, notably Switzerland, but the effort still hangs fire. A company, with a capital of $2,125,000, has been formed at Moscow to produce benzol.

[At the close of this review a tribute is paid to the recent dyestuff census, compiled and published by the American Department of Commerce. A portion of this is reproduced below.]

The United States has gone into the question thoroughly and systematically. A dyestuff census has been prepared and published by the Bureau of Foreign and Domestic Commerce. This is an enumeration of the dyes imported into the U. S. A. from Europe during the year preceding the war, and is published to assist American manufacturers in estimating the normal demand for each individual color. The extent to which most colors have been used in the country has in the past been known only to the importers of the foreign product. It was recognized that an intelligent effort to build up a comprehensive, self-contained American coal-tar industry must rest upon the solid foundations of accurate statistical data concerning the American market for artificial colors. In no other way can the creators of such an industry avoid overlapping and tentative struggles to adjust productive mechanism to a vague, indefinite demand. In the dyestuff census the Government has gathered together the statistics required. The work was compiled from the Customs documents in the possession of the Treasury Department, and several months were required by Dr. Norton, the author, and a staff of clerks to assemble and tabulate the data. It is the first time that a census of colors has been compiled by any government. The exact title of the report is "Artificial Dyestuffs used in the United States," Special Agents Series, No. 121. It contains 219 pages of statistical matter, and in addition an elaborate text. The total annual consumption of the U. S. A. is returned as 42,839,052 lbs., against a total annual importation of 41,653,136 lbs. by Great Britain, part of which is re-exported. In a masterly analysis of this census by Mr. C. M. Whittaker, of British Dyes (Limited), it is pointed out that although it has been stated that the Germans make their profits by the patented colors it is in fact the simple colors that are required to keep the textile trades in full swing. Many more dyers are held up for lack of the bread and butter dyes than for want of specialities.

The importance of the American inquiry to other countries depends on the fact that there is a certain parallelism in the consumption of the diverse countries, so that from the American consumption of a particular color an approximate idea may be gathered of the British and French consumption of the same color.

The French consumption of artificial colors is estimated at 9,000 tons annually, worth about $5,000,000; the English consumption may be gathered approximately from the American census, at any rate with a sufficient exactness to arrive at the relative importance of a given color, and to determine whether it is worth while to manufacture it.

A NEW METHOD FOR THE USE OF CHROME MORDANT

In the prevalent methods for using the chromates as mordants to fix various artificial and natural dyes upon textile fibers, it is customary to treat yarn or fabrics with a solution of a chromate—usually potassium dichromate,—and then introduce them into a bath containing the color in solution. The operation is conducted in the presence of a reducing agent, such as a tartrate. The sequence of the treatments is often reversed. In whatever order the successive steps of the operation are performed, great care, and much labor and time are involved. Otherwise a certain waste of coloring matter ensues. Under the most favorable conditions, there is a tendency to weaken and harden the fiber.

Dr. William Beckers and Dr. I. Dreyfus of Brooklyn, N. Y. (American Pat. 1,228,089, of May 29, 1917), have devised a new and simple process, by which the disadvantages of the current methods are materially obviated.

They find that if neutral alkaline chromates are dissolved in a strong solution of glucose. and this is added to an aqueous solution of logwood, alizarin blue, or similar natural and artificial colors, a chromium compound of the latter is obtained which is perfectly soluble in water. Textile fibers, introduced into such a solution, absorb the compound with perfect ease; the penetration is complete; and a permanent, insoluble combination between the fiber and the mordanted color is effected.

The following example illustrates one method of applying the new invention: "Dissolve 108 pounds of glucose in 216 pounds of water and gradually add 55 pounds of neutral sodium chromate with constant stirring, maintaining a temperature of 80° to 90° C. Heat until the presence of chromic acid cannot be detected by an acidulated solution of potassium iodide. The whole operation generally requires from three to six hours. Introduce acetic acid, which requires about 20 pounds of acetic acid of 70%, to neutralize the alkali liberated. To the solution of the chromium compound thus formed, add a solution of 2,100 pounds alizarin blue, 20% paste, in sufficient water, with constant stirring. The resultant clear solution of the chromium compound of alizarin blue may be used directly in the dye bath with the addition of the proper dyeing accessories, such as acetic acid or sulfuric acid.

Not only can such a solution be used directly as a dye bath, but it can, also, be evaporated to dryness, after being rendered slightly alkaline. The dry color compound, thus obtained, is readily soluble in water, and its solution can be used in the same manner as the original solution from which it was separated.

This new process, if sucessful, will notably simplify operations for the prospective manufacture of a large number of soluble mordant colors for household use.

COAL-TAR RESEARCH AT HUDDERSFIELD.

The local authorities at Huddersfield, a leading center of the English dyeing interests, have taken active steps to establish, in connection with the Technical College, extensive laboratories for research in coal-tar chemistry. Generous support in the way of subscriptions shows that the project meets a wide-felt need.

THE WAR-TIME UTILIZATION OF GERMAN COLOR PATENTS IN GREAT BRITAIN.

The British Comptroller of Patents is authorized by law to grant permits for the use, during the war, of processes covered by patents owned by enemy aliens. L. B. Holliday & Co., of Huddersfield, recently applied for licenses to operate under 19 valid patents issued to Germans, and connected with the manufacture of coal-tar dyes. A royalty of 2½ per cent. on the selling price will be paid by the licensees.

AMERICAN SYNTHETIC INDIGO.

There is a genuine feeling of pride among American chemists over the perseverance and energy displayed by the Dow Chemical Co., of Midlands, Mich., in successfully overcoming a multitude of difficulties and obstacles, and permanently establishing in our country the manufacture of artificial indigo, the most important of all the coal-tar colors. The daily production had attained 1,200 lbs. of 20 per cent. paste on June 1, and the output is steadily increasing. The above figure is equivalent to an annual production of about 186 short tons. Prior to the war the annual consumption of artificial indigo in the United States was somewhat over 4,250 tons.

NEW DYE DISCOVERIES REPORTED.

Curiosity is growing over the reports regarding the discovery of two important dye processes that are expected to prove valuable to this country in its efforts to build up a home industry in aniline dyes and coal-tar products. The discoveries were made by a chemist in the dye plant which has been established by the Bureau of Chemistry of the U. S. Department of Agriculture, at Rosslyn, Va., and although it is desired to prove its commercial practicability before issuing an official statement, it is believed that a dye which has heretofore been very expensive can now be manufactured for a fraction of its previous cost.

V

NATURAL DYES

THE PRESENT POSITION OF NATURAL DYES IN BRITISH INDUSTRIES

[Great Britain was forced, during the present war, at a much earlier date than the United States, to resort extensively to the use of natural dyestuffs. An English expert recently contributed to the columns of the London *Times*, the following valuable study on the present position of this category of coloring materials.—Ed.]

Indigo, madder and logwood were the mainstays of the textile colorist before the advent of the artificial coloring matters. Madder, second in importance of these, has been entirely replaced by synthetic alizarin in dyeing Turkey red on cotton, and is used to a very limited extent in wool dyeing. The exports fell from over 5,000 long tons in 1868 to a little more than 200 tons in 1892.

Indigo has always been regarded as the queen of dyestuffs. As late as 1897 the Board of Trade returns showed that the value imported into Great Britain exceeded that of all the aniline and alizarin colors of every description. It was hurt badly by the more general adoption of khaki and field-gray in uniforms Since the discovery of a satisfactory commercial process of synthesizing its principal coloring matter, indigotin, it has been left to some branches of the woolen dyeing industry. As in the case of madder, the synthetic substitute is much easier to use, but in the case of indigo the natural product contains other tinctorial matters, in addition to indigotin, which for this reason will probably never entirely supersede it. Since the war it has been eagerly snapped up as it came on to the market, and quickly came under Government control. The Indian planters and merchants have been urgently advised to send it out in a form more nearly approaching that of the synthetic product, and as a readily useable paste or powder it will have better competitive chances.

Logwood is the most important of the natural dyewoods and has best held its ground. It gives various colors with the mordants. In this way with bichromate it gives blue and black, with iron black, with copper olive and greenish black, with aluminum salts violet blue, and various other tints with other mordants. Before the days of the artificial coloring matters it was largely used for all these tints, alone and in combination with other dyes, but latterly its employment has been chiefly confined to the production of incomparable bloomy blacks. Logwood extracts and haematin, the coloring principle extracted from the wood itself, have been put on the market, and since the war began have been put to many of their original uses as polygenetic dyes.

Natural Colors in Chief Demand.

Although coloring matter is largely distributed in the vegetable kingdom, the number of natural colors employed before the days of the coal-tar dyes is surprisingly small. In addition to the three mentioned there were peachwood, camwood, barwood, saunderswood, orchil and cudbear, fustic, fustet, weld, quercitron, Persian berries, turmeric, cutch, sumac, and a few other tannins. Most of these have survived the competition of the coal-tar colors, if for restricted uses only. Since the war they have been eagerly in request. In the States some inferior and despised dyes, such as Lima wood, known as hypernic, have come again into vogue. The osage orange-tree, long known as a dye locally and very like fustic in its properties, has found employment and has been prepared as an extract known as aurantine.

As regards natural coloring matters, it is this question of collection that is often the crucial point. One of the most persistent questioners in Parliament, during the early days of the war, pointed out that it was notorious that an infinite number of plants yielded dyes, and asked why the British fields could not serve the needs of the dyer. In some cases, but for the difficulties of collection, British natural products would be available. Take privet, for instance. It gives a fair yield of a coloring principle, very similar to that of fustic. But all the privet in the kingdom would not go far. In competition with fustic it could not be cultivated to advantage.

A natural coloring matter, in order to come into commercial use, must be available in large quantities and stand a competitive test in other respects with the dyestuffs that have been proved by centuries of use. This is why the long lists of natural dyestuffs, in local employment all over the world, that have lately been given in technical publications, are almost solely of academic interest. India, in particular, teems with native dyes, but they have all been tried long since, and most of them condemned. Some, like kamala for instance, are of great beauty, but of little permanence. Others are too inaccessible. The bulk of them are similar to dyes in ordinary use, but poorer in coloring principle. The same objections apply to the dyes used in the Highlands, excellent for local uses, but for one reason or other not marketable.

Eastern Dyes and Methods.

The excellence of Eastern results in dyeing and printing, Persian carpets and Javanese batik work for instance, is often pointed out as a proof of the superiority of their natural coloring matters. The fact, however, is that the dyes used are the same and similar in their coloring principles to those in the list above There are several madder-like plants in the East, for instance, and local varieties of indigo. The superiority is mainly attained by the slow, laborious handwork, which modern conditions no longer permit in the West.

One result of the war has been the awakening of the public to the fact that the use of natural colors does not necessarily imply fastness, and that, on the other hand, the coal-tar colors are neither necessarily loose nor garish. The disappearance of some favorite tints and the inability to guarantee colors as fast to washing have been educative.

The demand for natural dyestuffs since some classes of coal-tar colors have been unobtainable is best shown by the Board of Trade returns. It is estimated that the output of dyewood extracts has been trebled during the war. Our imports of extracts for dyeing have risen in value from $673,676 in 1914 to no less than $3,265,315 in 1916. The following table shows our imports of dyestuffs and dyewoods during the last three years:

IMPORTS INTO THE UNITED KINGDOM.

	1914		1915		1916	
DYESTUFFS:	Lbs.		Lbs.		Lbs.	
Cutch	6.671,616	$393,168	10.284,736	$641,661	14,698,656	$1.256,141
Extracts for dyeing	*	673,676	*	1,686,344	*	3.265.315
Indigo	595,168	884.844	2,807,584	6,120.177	3,417,456	7.081,958
Unenumerated	16,831,472	1,636,590	31,379,600	7,111,977	30,355,136	10.949,074
TOTAL	....	$3,588,278	....	$15,560,149	....	$22,552,488
DYEWOODS:	Long Tons.		Long Tons.			
Logwood	9,343	$248,209	5,947	$203.215	*	*
Other	7,027	194,429	24.047	813.562	*	*

*Statistics not yet available.

NATURAL INDIGO

As one result of the great war, it is possible that there may be more of a commercial future for natural indigo than has been the case since the beginning of the present century, and the advent of the synthetic product.

The great advantage of the latter is due to the perfect uniformity of tint, and the equal uniformity of strength. The most common form in which artificial indigo appears on the market is that of the 20 per cent. paste. The dyestuff contains exactly 20 per cent. of indigotin, and is free from any admixture of closely allied tinctorial matter.

The natural indigo of India and other Oriental lands, as well as of Central and South America, is of the most variable composition. The indigotin content ranges from 20 to 60 per cent. The indigotin is, furthermore, accompanied by varying amounts of other more or less closely allied tinctorial substances, the most notable of which is isomeric indirubin. As a result the dyer is unable to use the natural dye with absolute certainty as to quantity required, and as to uniformity of shade.

It is an open question whether, apart from the above considerations, indigotin can be obtained most economically by synthetic processes, or by the cultivation of the choicer varieties of *Indigofera*.

The cessation of all export of artificial indigo from Germany has, naturally, stimulated a vastly increased production of the natural dyestuff in India, and in adjoining lands, where the cultivation of the plant has been continued to some extent, despite the competition of the Occidental, synthetic product. Thus, during the season of 1915-16 the acreage devoted to indigo culture in India increased by 112 per cent., while the increase in the export was 145 per cent. During the past season the exports show an increase over 1915-16 of 24 per cent.

The question has arisen as to the possibility of perfecting and standardizing the Oriental product, so as to do away largely with the conditions which permitted so easy a conquest by the coal-tar competitor.

It has been taken up actively and intelligently by the Indian government. Experts have been busily occupied with the requisite researches. As a result it has been found feasible to produce a standardized paste, containing 18.9 per cent. of indigotin, free from many of the disadvantages enumerated above. A half-ton of this paste is now being thoroughly tested by various dyeing firms.

There seems to be little or no doubt that a standard paste, of uniform strength and tint, can be regularly produced in India. Interest now centers about the possibility of placing it upon the market at a price enabling competition with the German and Swiss artificial indigo, upon the return of normal industrial conditions. The problem depends essentially upon a distinct increase in the amount of indigo plants produced per acre, and, also, in the quantity of indigotin extracted from the plants.

The solution of the problem will result, apparently, from the cooperation of the bacteriologist. Indigotin is not present as such in the indigo plant, but as the glucoside of indoxyl, the so-called indican. From this combination it is liberated by the action of dilute acids or of certain enzymes and subsequent oxidation with atmospheric oxygen. Bacterial investigations are now under way in regard to a systematic control of the process of fermentation which takes place in the steeping vats.

Great variations in the yield of different factories from plants grown under similar conditions of soil and climate have been found to be due to the presence or absence of specific bacteria which infect the vats. The task for the scientist is to ensure artificially the presence of the beneficial organisms and the elimination of those which are deleterious.

It would certainly be a novelty in the history of chemical technology should India recover her oldtime supremacy as a source of indigo, after an interruption of a score of years, as a direct result of the world conflict, and with the cooperation of our modern, highly-perfected methods of bacteriological investigation.

One is tempted to inquire, whether there might not be a similar return of madder to its former position, as a commanding factor in the tinctorial world, should the process of fermentation by which alizarin is liberated from the glucoside, Ruberythric acid, present in the madder root, be subejcted to careful bacteriological investigation.

The possibilities of natural indigo should not be overlooked in the United States. Nearly two centuries ago the culture of the indigo plant was introduced into Georgia and South Carolina by an enterprising woman. Climate and soil seemed to be peculiarly propitious. By 1776 the export of American indigo to Europe had assumed notable proportions. The War of the Revolution brought the industry to a sudden end, and it has never been revived.

$135,000 Extension for Schoellkopf Co.

Plans are being completed by the Schoellkopf Aniline and Chemical Co., Buffalo, N. Y., to build a $135,000 extension. The new structures comprise an ice plant and factory and machine shop.

SAYS U. S. ARMY HEADS DISCRIMINATE AGAINST VEGETABLE DYES.

Because, he declares, the depot quartermaster in Philadelphia showed discrimination in favor of coal-tar dyes and against vegetable dyes for use in dyeing khaki, C. R. Delaney, of J. S. Young & Co., manufacturers of the latter class of dyes at Hanover, Pa., has voiced a vigorous protest in behalf of vegetable dye manufacturers in general.

"We require the use of coal-tar dyes instead of vegetable dyes," the quartermaster is quoted as replying to an inquiry from Mr. Delaney. In protesting against this ban on his product, the latter avers that "while it is possible that our American manufacturers of coal-tar dyes have not been able to imitate the German in respect to artificial khaki colors, nevertheless there are millions of yards of khaki cloth dyed with natural colors, both mineral and vegetable, that have never seen the inside of a coal-tar color works."

He further points out that quercitron bark extract which is the base color for dyeing khaki by the vegetable process, is manufactured in this country on a scale which makes coal-tar color production look small in some respects. Flavine is said to be even more powerful than some of the synthetic dyes, and before the war German and Swiss makers of fast yellows, according to his statement, bought 60 per cent. of the output.

VI

SYNTHETIC DRUGS AND PERFUMES, PHOTOGRAPHIC DEVELOPERS

SYNTHETIC PERFUMES

Possibilities of English Manufacture.

By Ernest J. Parry, B.Sc., F.I.C.

[Prior to the war the manufacture of synthetic perfumes, largely from coal tar derivatives, was steadily increasing in quantity and broadening in scope. The following study on the posibilities by an English authority, portrays, to a great extent, the nature of the problem to be faced, if American chemistry creates its own independent, artificial perfume industry.—Ed.]

In considering the degree of success which has been, or is likely to be attained in the manufacture of synthetic perfumes in this country, a proper conception of the meaning of "synthetic perfume" is absolutely necessary.

There are three different classes of bodies to which this term is applied indifferently by the layman, and more or less carelessly by the expert. To each of these three classes entirely different considerations apply. In the first place there is the true synthetic perfume, that is, one that has been built up from comparatively simple substances by chemical means. Secondly, there is a group of artificial perfume bodies, which, truly, are synthetic, but not in the same sense as the first class. They are bodies which by more or less simple chemical means are manufactured from other compounds, complex in their nature, which are found already existing in other perfume materials. The third class, which may be dismissed without serious consideration, are merely mixtures of natural with synthetic perfumes.

Two Principal Classes.

The two serious classes of synthetic perfumes may be illustrated by the following examples. Benzaldehyde, a synthetic manufactured from coal-tar products, is a faithful representative of the almond odor; phenylethyl alcohol is also made from coal-tar sources, and is an indispensable ingredient in artificial rose odors. These and hundreds of others belong to the first group above mentioned. But clove oil contains a substance, eugenol, in itself of very complex constitution, which can be transformed by chemical means into vanillin, the true artificial representative of the vanilla odor. The essential oil of the lemongrass contains citral, which is, in similar manner, transformed into ionone, the basis of all the artificial violet perfumes.

Now in dealing with these two groups of synthetic perfumes, the following points have had considerable influence on the question of manufacture in this country. There is in the first instance the lack of skilled labor available; secondly the lack of co-operation; and thirdly the lack of experienced business men with a full appreciation of the value of the trained technical chemist.

There have been highly successful attempts to manufacture a number of these synthetic perfumes, and those firms who have undertaken their manufacture will no doubt reap a rich harvest later. But efforts to manufacture one or two of these articles are hardly likely to be successful, as the expense of rent, wages, and plant cannot be met unless the factories are working regularly on a number of bodies, and so ensuring a continual output and turnover of capital.

Manufacture in England.

Taken as a whole, this country has not placed itself in a position seriously to compete with the German trade in these articles, nor, except in a few isolated cases, have serious attempts been made to do so. The industry is a large one, and an attempt to capture a share of it should be made by British manufacturers. But it is a business in which nothing but the highest skill and incessant industry will ever win success. So far as one can foresee, a much closer cooperation between the technical chemist with special knowledge of the subject and the business man who is intent on building up this industry is necessary. Committees of pure scientists, Government subsidies, and the like are all very well, but will not be the sine qua non of success. The business man must realize the inter-dependence of many branches of chemical industry and must realize that German success has been built up by using to the full this inter-dependence under the advice of armies of skilled chemists.

The want of raw materials, such as benzyl chloride, benzaldehyde, the cresols, magnesium, potash, and many others, has, of course, seriously handicapped the starting of this and similar industries, and Germany had created almost a monopoly for herself in these and many other articles. The electrolysis of our salt produces the chlorine, and we have a good supply of toluene in our coal-tar. These two bodies will produce all the benzyl chloride we require, especially as the conditions become more normal. And careful examination will show that all raw materials can be obtained by the proper exploitation of our resources.

There are no valid reasons why the synthetic perfume industry should not be as large in England as it bids fair to be in France. At present, unfortunately, the actual efforts made, important and successful as they are, are not commensurate with the possibilities of this attractive branch of chemical manufacture. In France there has been formed, under the auspices of the Ministry of Commerce, an "office of chemical and pharmaceutical products," whose work in moderating the effects of the shortage of raw materials and in generally assisting the development of the chemical industries is very highly appreciated. When one considers the enormous expansion in chemical works and apparatus that the manufacture of explosives has rendered necessary in this country, the thinking chemist is astonished at the lack of foresight in considering what the future of these works is to be.

SYNTHETIC DRUGS OBTAINED FROM COAL TAR

[The following article by a British physician gives an admirable portrayal of the evolution of an important class of highly valuable therapeutic compounds, from various coal-tar colors—the most brilliant triumph of recent chemical synthesis.—ED.]

The history of the relationship between the dye industry and modern scientific medicine is one of the romances of the industrial era. It is, indeed, a remarkable circumstance that the most potent of all the remedies which have been introduced during the last few years, and not only the most potent, but also the most precise and accurate, should be almost without exception, members of the great family of aniline derivatives. Even today, when the thing is an accomplished fact, people express surprise that anyone should have thought of looking in this group of chemicals for therapeutic agents.

The answer to this question is that the investigators who first dealt with these aniline compounds as medicines were attracted to them just because they were dyes. Modern pharmacology, the science of drugs and their action, desired to establish in what manner medicines acted, upon what parts of the body exactly they exercised their effects, and what changes they brought about by their presence. Obviously one of the simplest ways of answering these questions was to use some dyestuff which would leave traces of its presence behind it in the animals experimented upon.

That was one aspect of the investigation; the other was dictated by the fact that it was desired to find some substance which would act as a substitute for quinine. The result was antipyrine. Other potent drugs having the power, like quinine, of reducing temperature and alleviating pain were the synthetic aniline compounds known as acetanilide and phenacetin.

Pioneer Work.

At this point there came into the field that very brilliant worker, Paul Ehrlich, with whose name the aniline drugs will ever be associated. He came opportunely. The Germans had practically captured the dye industry and were devoting all their efforts to develop it. Ehrlich was given every opportunity, and his wishes in regard to new compounds were eagerly carried into effect. He had the whole industry, literally, at his disposal.

Ehrlich set to work with tremendous energy and soon formulated the generalization that each of his dye-drugs had specific medicinal properties which were peculiar to it, and were intimately related to the chemical constitution. Thus, if the structure of any dyestuff was altered the effect of the dye as a drug was altered also. He was able to show that each tissue responded in a special way to each dye, and that that response was specific for and characteristic of that tissue. Out of this arose the remarkable development in microscopic staining from which the sciences of histology, and, more important still, of bacteriology, have derived such immense impetus. Ehrlich showed that methylene blue when injected into the living animal was able to "pick out" the nerve endings in various structures while it did not stain other structures in the neighborhood. The advantage of this quality from the point of view of the student needs no emphasis. Again, Ehrlich showed that if tubercle bacilli were stained with fuchsin or methyl violet in the presence of aniline oil, they were able to hold the stain, even against the action of a concentrated solution of sulfuric acid. Other bacteria could not hold the stain against acids, and thus it was possible to distinguish the tubercle bacilli easily in any specimen. They alone retained the stain and could be picked out with certainty. For this reason tubercle bacilli are now commonly spoken of as being "acid fast." The discoverer of the tubercle bacillus, Koch, said it was entirely due to Ehrlich's work that the method of determining the presence of tubercle bacilli had been rendered so easy and certain, that almost anyone who cared could carry it out. A further effect of this work upon stains was the ability to distinguish the various kinds of white blood corpuscles, the "warrior cells," and from that investigation has arisen the important science of haematology.

The success of this work naturally encouraged other efforts. Ehrlich began to attack the problem of the diseases due to "trypanosomes," of which tsetse-fly disease and the human "sleeping sickness" are important examples. Mice were inoculated with the trypanosome of "mal de caderas," a South American trypanosome disease of horses, and Ehrlich soon showed that the dye trypan red,[*] a benzidine compound, was capable of killing the trypanosome in the mouse, and so of curing the animal. The dye had no ill-effect upon the mouse's own tissues, although the whole animal was stained red for months.

Important Discoveries.

This was a very important discovery, for it foreshadowed the new doctrine of specific effect, *i. e.*, that a drug must affect only one definite kind of structure, and not all the structures. It must be able to seek out germs of a special kind in a man's blood and kill these germs without in any way affecting the tissues of the man himself. The next application of this principle was the treatment of the disease of cattle and dogs known as "piroplasmosis" (because of the presence of a minute micro-organism, the piroplasma) by means of another benzidine dye, trypan blue,[†] an improvement on trypan red introduced by the French workers Mesnil and Nicolle. The piroplasma is introduced into the animal's body by means of a tick. This discovery has naturally and necessarily had a very great commercial value. The names of Sir S. Stockman, of the Board of Agriculture, and of Professor Nuttall, of Cambridge, are associated with this work.

Meantime at the Liverpool School of Tropical Medicine efforts were being made to use atoxyl (an organic aniline compound of arsenic) for the treatment of sleeping sickness. A modified success resulted, but unhappily the drug proved dangerous because of its effect upon the nerves of the eyes, and its use has been practically abandoned.

Ehrlich also showed that methylene blue was capable of curing certain varieties of malaria. He then began the labors with which his name will be for ever associated—the search for a cure for syphilis. His working motto was *corpora non agunt nisi fixata,* and keeping this dictum in view he tested some hundreds of organic arsenical compounds. His work brought him at last to the famous yellow dye, a derivative of a mother substance like benzidine, but with arsenic in the molecule, which he named "salvarsan," and which is popularly known as "606"—its serial number. This drug is a specific cure for syphilis, because it kills the *Spirochaete pallida,* the germ of the disease; it has also proved to be a specific for the tropical diseases, relapsing fever and yaws.

Dye-Drugs.

Salvarsan was the key-stone of the edifice of the dye-drugs. Salvarsan proved that the idea that it was possible to obtain drugs which would kill germs, and not in any way harm the bodies of the persons affected by these germs, was no chimera, but a true scientific conception. This idea of specific action has borne very valuable fruit. At the Middlesex Hospital Dr. Browning, a former pupil of Ehrlich and director of the Bland-Sutton Institute of Pathology, worked out a method of discovering the presence of typhoid bacilli in specimens of water and other fluids, such as the intestinal contents, where numerous other germs are also present. This depends on the fact that the triphenyl-methane dye, brilliant green, exercises a remarkable destructive effect upon the bacillus coli of the bowel, but little or no effect upon the bacillus of typhoid fever. If brilliant green was added to such a mixture of a few typhoid bacilli along with abundant colon bacilli, then all the germs present except the typhoid germ were destroyed, and the recognition of the typhoid organism was rendered easy and certain.

Perhaps the most striking of all the examples of specific effect was found in Ehrlich's "pyronin," which had an effect, not only on one particular kind of germ, but actually upon one particular part of a particular germ. Thus the germ known as the trypanosome to which reference has been made (the parasite of sleeping sickness), has two nuclei or "nerve dots" in its substance. One of these nuclei is situated in the tail of the germ, and so is known as the caudal nucleus. It was found that if mice were inoculated with this germ and then injected with pyronin, the caudal nucleus disappeared from the germs in the mouse's blood. Strangely enough, the other nucleus did not disappear, nor did the germs lose their power for evil. Thus it was clear that this pyronin had a specific effect upon an infinitesimal particle of matter in the body of an infinitesimal germ, and on this particle only. Exact, specific effect could go no further than this.

---

[*] Disulfo diphenyl disazo bi nitr n phenylene-diamine.

[†] Sodium salt of ditolyl bisazo bi amido naphthol disulphonic acid.

The latest of the dye-drugs is "flavine," also a discovery of Dr. Browning's. It is a yellow acridine, related to substances used in commerce for dyeing leather a brown color.** Flavine is known as the nearest approach to the "ideal antiseptic," because it destroys the germs of blood-poisoning in a wound without in any way interfering with the activity of the white warrior cells, which are the patient's own defense against the germs. The best of the old antiseptics are as destructive of white warrior cells as of germs, and the worst of them are much more destructive of warrior cells. Flavine, therefore, marks an important advance, and will soon be in universal use as an antiseptic.

For the moment the story ends here; but only for the moment. It is a safe assertion that many more of these specific drugs will be yielded by the coal-tar group, and that the demand for them will grow with experience of their uses. Already the scheme for combating venereal disease has established the use of salvarsan on what may be described as a national basis. From the commercial point of view this development is worthy of careful and earnest study. The scientist is to a great extent in the hands of the business man, since if further advances are to come, it is necessary that the pathologist should be brought into the closest touch with the technical chemist. It may be hoped that they will work together for the common good.

Picric Acid from Certain Gums.

It has long been known that the gum-resins, obtained from plants of the genus Xanthorrhoea and known commercially as acaroid, black-boy, botany-bay and grass-tree gums, yield picric acid upon treatment with nitric acid. This fact has not been utilized hitherto in a commercial way on account of the violence of the reaction, and the difficulty of controllng it, so as to secure a satisfactory output. Miller and Irlam (Br. Pat. 104,352, of 1916) have overcome this difficulty by treating the purified gum with limited amounts of acid, and in the cold, or at temperatures not exceeding 40° C. Not only picric acid, but also nitro-phenol and dinitrophenol are obtained by altering quantity and temperature.

DISINFECTANTS DERIVED FROM ACRIDINE DYESTUFFS

Dr. P. Hüssy and Dr. M. Hartmann, of Basel, Switzerland, have recently patented (Amer. Pat. 1,227,624, of May 29, 1917), processes for preparing a series of bactericidal derivatives from acridine dyestuffs, which are especially effective against streptococcus and splenitis bacilli.

The chief acridine dyes are phosphine, benzoflavine, acridine orange and acridine yellow. They are prepared from aniline, toluidine, dimethyl-aniline, etc. Theoretically, they are derivatives of the base acridine, $C_{13}H_9N$, which occurs in coal-tar.

The invention is described as follows:

"It is found, that valuable disinfectants of the acridine series are obtained, by acting with a soluble silver salt, on acridine dyestuffs, which may be alkylated at the acridine nitrogen, in presence of a convenient solvent, as for instance water or alcohol. The well defined crystalline compounds possess a prominent bactericidal action much superior to that of the heretofore known disinfectants with dyestuff character, as for instance the acridine dyestuffs employed as parent material, or certain derivatives of other basic dyestuffs, as for instance of methylene blue or rhodamine colors. Thus, for instance, the silver salts of the acridine derivatives, alkylated at the acridine nitrogen, act even in a state of the greatest dilution, (1:150000 to 1:180000), still growth checking, especially on streptococcus and splenitis bacilli, while the said alkylated acridine derivatives themselves show only a feeble development checking action already in dilution of 1:80000.

The toxicity of the new silver compounds is generally a trifling one and within the limits allowed for injection purposes.

For the preparation of the new compounds can be added, for instance, to a solution as concentrated as possible of the desired acridine dyestuffs, salt in a convenient solvent, as for instance, water or alcohol, a likewise concentrated solution of a silver salt soluble in the employed solvent, whereupon the crystallization of the silver compound formed begins mostly after a short time, and can be completed by refrigerating or, if desired, by adding a convenient precipitating agent, as for instance, ether. The separation of the new compounds is effected in the usual manner by filtration, washing and drying.

The new disinfectants constitute red or black powders, which dissolve in water with red to green coloration, in alcohol, acetic ether, glacial acetic acid and acetone with a strong fluorescence and in concentrated sulfuric acid with yellow to red colorations.

The process is illustrated by the following examples:

Example 1:—12.5 parts of the chemically pure nitrate of the acridine dyestuff, methylated at the

---

**Flavine is closely related to phosphine—a mixture of the salts of unsymetric diamido-phenyl-acridine with higher homologues.

acridine nitrogen, obtained in the known manner by heating 2:7-dimethyl-3:6-diamino-acridine with methyl chloride under pressure, are dissolved in as small a quantity as possible of boiling distilled water, and hereafter a solution of 7:8 parts silver nitrate, in a small quantity of water, is added to the solution. The new silver compound separates immediately, in the form of a crystalline tile-red precipitate; the separation is completed by cooling the mass or by allowing the same to stand for a certain time. Hereafter the precipitate is filtered off, washed first with a small quantity of ice water and afterward with alcohol and ether and dried *in vacuo*. The new silver compound constitutes in a dry state a brown-red powder, dissolving in water to red-orange solutions, in alcohol with orange-yellow coloration and strong fluorescence, in acetone, acetic ether and glacial acetic acid with yellow-green fluorescence and in concentrated sulfuric acid with yellow coloration. It is insoluble in ether.

Example 2:—20 parts 3:6-diamido-acridine, in form of the pure base, are suspended in a small quantity of hot water, and to the thus obtained suspension is added, while stirring, pure nitric acid, until the dyestuff is completely dissolved. Then a solution of 17 parts silver nitrate in 50 parts water is added, whereby the black-brown silver compound separates. After the mass has been allowed to stand for a certain time, the new silver compound is isolated by filtration, washed and dried *in vacuo*. It constitues a blue powder, which dissolves in water with green colorations and in alcohol, acetone and acetic ether with yellow-green fluorescence, and in glacial acetic acid with a brown-red coloration. It dissolves in concentrated sulfuric acid with wine-red coloration of strong fluorescence. It is insoluble in ether.

Interest Aroused in Suit Over "Aspirin" Trade-Mark

Manufacturers of drugs and medicines are watching with interest the progress of the suit brought by the Bayer Company, Inc., against the United Drug Company for alleged infringement of the trade-make "Aspirin." The plaintiffs contend that although the patent on the Hoffman process for the manufacture of acetyl salicylic acid expired in February of the present year, the trade-mark under which this drug has been advertised remained their exclusive property. The defendants hold that they are entitled to the use of the name "Aspirin," because it has "become generic within the principles laid down by the Supreme Court in the case of Singer Manufacturing Company v. June Manufacturing Company." Several concerns are now using the Hoffman process, but with the exception of four, including Lehn & Fink, New York, and the defendants, all are labeling their product "Acetyl Salicylic Acid." The suit is being tried in the United States District Court for the Southern District of New York.

EFFECT OF THE WAR ON THE PRODUCTION OF PHOTOGRAPHIC DEVELOPERS.

By T. THORNE BAKER.

Photographic developing agents presented a somewhat difficult problem soon after the outbreak of the war. The early ferrous oxalate developer, used when dry plates superseded the collodion processes, has the peculiar disadvantage that nearly half the speed of the plate is lost, which in these days of high-speed photographic work is, of course, a point of great importance. Nevertheless, a return to ferrous oxalate developers seemed almost necessary.

It so happened that practically all the modern organic developing agents—coal-tar derivatives—were manufactured in Germany. Many of them were the subjects of patents, and most of them could not be made on an economical basis outside of Germany. In the case of one in particular—hydroquinone—the Germans were able to sell this at a price so low that competition was almost out of the question, as the substance was produced in large quantities as a by-product in the manufacture of various coal-tar derivatives. In other cases, similar by-products or their derivatives, found to possess photographic reducing powers, were systematically "boomed" by means of trade literature until a market was established and so a channel secured for their outlet.

The use of hydroquinone, noted in 1880 by Sir William Abney, was followed in 1884 by hydroxylamine, and a year later by phenyl-hydrazine. In 1888 Andresen patented para-phenylenediamine. A year later, the naphthalene derivative known as eikonogen was discovered, and in 1891 the applicability of para-amidophenol, from which are derived many of the most important modern developers, particularly metol. This in 1914 was employed on an immense scale for cinematograph films and the development of X-ray plates.

Metol Substitutes.

Several substitutes for metol have since then been produced, for which various advantages have been claimed. In certain ways it is, perhaps, doubtful whether manufacturers have yet attained to the perfection of German-made metol, but the photographic properties of the substitutes are so satisfactory that no doubt need be entertained of our ability to compete in quality.

The high state of organization and the complete way in which nearly all coal-tar by-products are utilized enabled German aniline dye firms to produce these organic reducing agents at prices impossible in other countries in the present undeveloped state of the dye industry. Hence the cost of production of developing substances will depend to a large extent on the progress and expansion that take place in the manufacture of coal-tar derivatives. In the matter of the essential raw materials—benzene, phenol and naphthalene—we are, of course, happily placed. In our practical knowledge of the technical chemistry involved, we probably have much to learn.

To sum up the result as we find it today, it may be said that the large number of photographic developers in use two and a half years ago, each of which had its adherents, has diminished to two or three for the great bulk of photographic work—pyrogallol, hydroquinone, and the various metol "substitutes." These have been successfully manufactured by British and American chemists, and there is good reason to hope that the cost of their manufacture will be reduced.

MAY WAIVE PATENT LAW TO PROTECT GOVERNMENT FROM EXTORTION.

Steps to prevent the exaction of extortionate prices from the Government for drugs, medicines, remedies or devices required by the army or navy during war have been taken by Senator Atlee Pomerene, of Ohio, who has introduced into the Senate a bill (S. 2363) authorizing the Secretary of War and the Secretary of the Navy to manufacture such necessities regardless of whether they are already protected by patents or trade-marks. By this means the owners of these patents or trade-marks will be effectually prevented from taking advantage of the present urgent need by raising prices on Government contracts, although they will be allowed to have adequate compensations for the use of their formulas or manufacturing methods, and will also have the privilege of keeping the Government from using them in case the compensation is, in their opinion, inadequate.

USE OF COAL-TAR DYES AS MEDICINES.

Certain coal-tar dyes check the growth of tuberculosis germs, and, to a lesser degree, the growth of typhoid germs, according to a recent announcement of Dr. Paul A. Lewis, of the Henry Phipps Institute of the University of Pennsylvania, through the "Journal of Experimental Medicine." The azo compounds, because of their nitrogen contents, exhibit this beneficial property, while methylene blue dyes also display great potency in arresting the development of germ life. Experiments to determine the effects of dyes on pneumonia germs will be undertaken shortly.

The Cost of Salvarsan.

The rector of a German university recently stated that while the cost of manufacturing a kilogram of salvarsan did not exceed 8 marks, or nearly $2, the drug was sold at 16,000 marks ($3,808).

French Duty on Saccharin.

A French internal consumption duty of 200 francs per kilo has been imposed on saccharin and all artificial sweetening substances or chemical products assimilated thereto.

VII

MISCELLANEOUS

Nationality and Chemical Research

Dr. Alfred Rée, President of the British Society of Dyers and Colorists, in his presidential address at Manchester, on March 30, gave some interesting data on the rôle of nationality in the evolution of the coal-tar color industry. While the great bulk of the progress has taken place in Germany, it would appear that a large number of the most brilliant discoveries in this field, made in German laboratories, are due to the talent of chemists of French, Alsatian or Swiss origin, some even of Polish or Anglo-Saxon origin. Some of the most clever and expert German industrial chemists spent many years in England and benefited by a close study of English ways and methods before attempting to accomplish their great work in the land of their birth.

The past dominance of Germany, and also of Switzerland, in technical chemistry is due chiefly to the enormous number of chemists in the two countries. Relatively, in proportion to the population, Switzerland has fifty times as many well-trained chemists as are found in Great Britain, and Germany has forty times as many. Among such battalions, even armies, the chances of bringing to the forefront men of pronounced inventive ability are vastly heightened.

British Exports and Imports of Chemicals

The exports of chemicals, drugs, dyes and colors from Great Britain, for the month of March, 1917, showed a slight decrease, as compared with the corresponding period in 1915 and 1916. The figures are:

March, 1915	£1,997,635
" 1916	2,046,398
" 1917	1,960,799

The imports of chemicals and allied products, for the first three months of 1917, show a marked falling off as compared with 1916. The value was £5,796,584. In 1916 it was £7,302,648. The shrinkage in purchases of foreign dyes indicates that the British production of artificial colors is steadily gaining ground.

Oakes Co. to Erect New Buildings.

Work will shortly be begun on the new factory and office buildings which the Oakes Manufacturing Co., manufacturers of natural dyes, is to erect in Steinway Avenue, Long Island City. The factory will be a two-story structure, 60 x 100, and the office three stories, 32 x 100. The estimated cost is $60,000.

BOOK REVIEWS

THE ANILINE COLOR, DYESTUFF AND CHEMICAL CONDITIONS.

From August 1st, 1914, to April 1st, 1917. A Series of Addresses and Articles, Compiled by I. F. Stone. New York. 224 pp. Privately Printed.

To all who have been associated with the rapid development of the American coal-tar color industry, since the beginning of the present war, Mr. Stone's historic survey has been exceedingly welcome. This development has been so swift, so marvelous, so unprecedented in its nature, that the time had arrived when we needed to have the various stages of progress, and all the multiple factors presented in the proper light and well-co-ordinated.

No one is better fitted by broad and generous participation in the evolution of our new industry to portray the successive steps since August 1, 1914, than the author. His positions as vice-president of the Schoellkopf Aniline & Chemical Works of Buffalo, the leading American company engaged in the production of artificial colors, and likewise as president of the National Aniline & Chemical Co., of New York, a great distributing agency, have brought Mr. Stone closely into touch with all phases of the situation—technical problems and commercial actualities.

As he possesses a rare talent of clear, lucid exposition, Mr. Stone has been frequently called upon to portray existing conditions, as well as the possibilities and probabilities of the immediate future, before gatherings of chemists and textile associations, as well as in the technical press. These public addresses and published contributions, coming at intervals of a few months, constitute a genuine series of dissolving views, and present, in admirable perspective, the successive steps leading up to the present status of the nation's new industry.

Out of 20 such portrayals, some 13 have been selected, and arranged in chronological sequence they form the chief portion of the volume. They begin with an address before the "National Printing Ink Manufacturers' Credit Association," on September 25, 1914, and terminate with a convincing argument for the "Permanence of the American Dyestuff Industry," delivered before the Textile Club of New York, on March 3, 1917

In order to heighten the value of the compilation as a historic document and complete the survey of the general subject, the author has introduced a few studies by others prominently identified with the movement. Among these are the address by Mr. D. W. Jayne before the Society of Chemical Industry, in 1915, on "The Possibility of Establishing a Complete Dyestuff Industry in America;" Dr. B. C. Hesse's exhaustive tariff history of coal tar dyes, "Lest We Forget! Who Killed Cock Robin?" of August, 1915; Mr. J. F. Schoelkopf's admirable presentation of "The Aniline Industry from a Manufacturer's Viewpoint," October, 1915; Dr. W. Beckers' address before the Second National Silk Convention on "The Relationship of the Manufacture of Explosives to the Manufacture of Dyestuffs," November, 1916, and Dr. Thomas H. Norton's portrayal of "The Expansion of the American Dyestuff Industry," February, 1917.

Professor W. M. Gardner compiled, on a somewhat similar plan, in 1915, his interesting volume on "The British Coal-Tar Industry," which includes 33 articles, by prominent British Chemists, from 1868 to 1915, depicting every phase in the slow evolution of the industry in England.

Mr. Stone's work is much more dramatic, in bringing vividly before our eyes the quick sequence of accomplishment, as we have reached in less than 3 years, the stage of development attained, in nearly half a century, in the birth place of coal-tar color chemistry, by our transatlantic cousins.

The book offers many temptations for more or less ample quotation. Suffice it to reproduce from the closing address an outline of the general situation, as it was three months ago, and as it is now practically:

"Practically the only colors which are not now made in this country of any consequence are indigo and anthracene derivatives, known as vat colors, for the dyeing of ginghams, shirtings, etc. (although at this time there is one factory being erected for the manufacture of indigo); but it is possible to secure natural products like indigo, logwood, fustic, cutch, flavine, etc., which can be substituted until the artificial colors are either manufactured or again imported. And then alizarin colors, for which there is, as far as I know, no plan to manufacture, are easily replaced by the so-called chrome colors, which are practically as fast and available for men's wear, sweaters, heavy woolens, etc., in black, blue, brown, green, yellow and red. Therefore the shortage of these alizarins is really not so serious. There are some colors for lakes, called the para colors, which are not made here; but the lake manufacturers can easily get what they want by making their own lakes from paranitraniline and beta-naphthol, which are made here. A few other colors not made here are such specialties as rhodamine, auramine, patent blue, etc., but some are being brought over from Switzerland and England in fair quantities, so that they are obtainable, and can be used in connection with American colors for blending shades and making mixtures."

* * *

"The principal point, to continue the successful manufacture, is the question of the manufacture of the intermediates, on which they depend as their raw materials, and it is the intermediate manufacturers who will need the most help to maintain their position."

* * *

"There is some criticism as to the quality of the coal-tar products made in the United States since the war; but to this I can say that they are identically the same in every respect as the European products, as they are made from the same chemical formulae, and there is no reason, therefore, why they should not be fully as good in every way if they are properly manufactured, which they are by the competent factories. The trouble is that people in comparing colors do not compare the same colors, but take some color which is especially adapted for certain purposes, and compare it with colors which may be used for the purpose, but are not so well adapted, due usually to the ignorance of the people who use colors."

* * *

"To sum up what is now being manufactured, I would say that practically a full line of basic, acid, chrome and sulphur colors are being made. People in criticizing the development of the color manufacture should not forget that it would be impossible for us to do in two years, since the war, what it has taken Germany over fifty years to accomplish; in other words, make a complete line of colors for every purpose; but in making the staple colors such as we have been able to do and getting them to a point where we can supply the whole consumption of the country, I think we have accomplished wonders in the short period since the war, or a little over two years.

"The definite answer in connection with the manufacture of dyestuffs in America is therefore, as I have already stated, that the present conditions of the dyestuff supply are very satisfactory, and the future outlook is still more satisfactory in that we will make more colors, and everything indicates that the larger part of the business will remain in the hands of American manufacturers even after the war, instead of the European manufacturers who in former years have had a practical monopoly of this business."

With this hopeful and optimistic conclusion of Mr. Stone, "THE CHEMICAL ENGINEER" is in most hearty accord.

PROFITS OF SWISS COLOR MANUFACTURERS.

The Sandoz Chemical Works Co., one of the four large firms of Basel, Switzerland, engaged in the manufacture of coal-tar colors, declared a dividend of 25 per cent. on its business for 1916, and paid, in addition, a bonus of 100 per cent.

ANNUAL CHEMICAL DIRECTORY OF THE UNITED STATES.

Editor, B. F. Lovelace, Williams & Wilkins Company, Baltimore, 305 pp. Price $5.00.

American chemists will warmly welcome the appearance of this first issue of a handy work of reference, long needed by the profession. The field for such a directory has broadened immensely during the past three years. A multitude of chemical products are now currently manufactured in this country, for which we depended entirely upon foreign sources in 1914. The same is true of a great variety of technical and laboratory equipment, in constant requisition by the teaching, research, analytical or manufacturing chemist.

The editor of the "Annual Chemical Directory" has followed Charles Reade's advice—"Put yourself in his place," and has brought together in easy, compact form the answers to all the multiple inquiries of What? and Where? which have been constantly on the lips of chemists during the busy months since 1914.

Two-thirds of the book is devoted to the two lists of American manufacturers of chemicals and of apparatus and equipment. In each section there is a highly detailed, systematic classification. Manufacturers are enumerated alphabetically, under each heading, by states and their cities or towns. The first section, covering American chemicals, will be a revelation to any who have doubted the ability of the country's chemists to establish successfully in the United States the manufacture of a great variety of products, for which we have depended hitherto upon European sources. This is especially the case with coal-tar crudes, intermediates and finished dyes, medicinals, etc.

The concluding portion of the directory contains a number of convenient reference lists: Professional chemical firms, laboratories, federal, state, municipal and professional; colleges and universities offering chemical courses (both American and foreign); agricultural experiment stations (American and foreign); Federal and State officials charged with the examination of foods, drugs, etc.; technical and scientific societies (American and foreign); periodicals devoted to chemistry and allied branches (American and foreign); chemical works appearing in 1916; progress of chemistry in 1916; new devices and methods for handling industrial chemical problems.

In its fullness and careful classification this new directory compares favorably with the ponderous "Adressbuch" of the German chemical industry, which has hitherto been a model in this field.

The first issue of such a directory naturally exhibits various errors of omission and commission, which can be easily rectified in subsequent editions. The editor frankly recognizes his limitations and invites constructive criticism and suggestions.

Greater fullness can certainly be attained in connection with certain branches of chemical industry. Under "Sulphur Black" but a single firm is listed, out of a score now producing the important dyestuff. The existence of an American factory for manufacturing synthetic indigo is not indicated; the companies now producing potassium compounds along the Pacific coast and in Utah, as well as in connection with the cement industry, are not mentioned, etc., etc.

It would be eminently desirable to distinguish sharply between manufacturers and dealers, in connection with both chemicals and mechanical equipment.

In the lists of foreign universities, periodicals and publications, orthographic errors are numerous. A variety of abbreviations are employed in the list of periodicals, for which no explanations are appended. The value of this list would be notably lengthened if the various journals, instead of following a single alphabetical enumeration, were classified under separate headings, analytical chemistry, electrochemistry, pharmacy, etc.; and further by countries under each subheading.

The survey of chemical progress during 1916 is so suggestive and stimulating that it could well have been expanded beyond its modest limits.

A valuable feature in such a directory—possibly in the advertising pages—would be statements, not too brief, regarding the courses in leading American universities and schools of technology, open to students of chemistry and chemical engineering.

Another feature of great convenience would be a classified list of chemical patents issued during the year.

T. H. N.

IX

CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS

JUNE 15, 1917

CRUDES.

Anthracene, 80 p.c.	lb.	.10	.12
Benzol, pure, water white	gal.	.45	.60
Benzol, 90 p.c.	gal.	.57	.59
Cresol, U. S. P.	lb.	.19	.20
o-Cresol	lb.	.30	.35
Cresylic acid, 95-97 p.c.	gal.	1.00	1.05
Cumene (pseudo)	lb.	..	..
Dip oil, 20 p.c.	gal.	.27	.30
Naphthalene	lb.	09½	.10
Flake	lb.	.10	.11
Balls	lb.	.12	.12½
Phenol (carbolic acid), U. S. P., cryst., drs.	lb.	.49	.51
Bottles	lb.	.51	.54
Pitch, various grades	ton	8.00	20.00
Pyridine	oz.	—	.25
Solvent naphtha, water white	gal.	.13	.20
Solvent naphtha, crude, heavy	gal.	.13	.16
Toluol, pure, water white	gal.	1.25	2.00
Toluol, commercial 90 p.c.	gal.	—	2.05
Xylene, pure	gal.	1.00	1.25
Xylene, commercial	gal.	.35	.40

INTERMEDIATES AND EXPLOSIVES.

Amido-naphthol disulfonic acid (H-acid: 1.8.3.6)	lb.	—	2.50
Amido-naphthol-sulfonic acid	lb.		1.75
p-Amido-phenol	lb.	5.50	6.00
p-Amido-phenol hydrochloride	lb.	5.00	5.50
Amino-azo-benzene	lb.	1.65	1.85
Aniline oil	lb.	.28½	.30
Aniline salts	lb.	.35	.36
Aniline for red	lb.	1.12	1.15
Anthraquinone	lb.	—	—
Benzaldehyde	lb.	5.00	5.50
Oil of bitter almonds	lb.	13.00	14.00
Without acid		17.00	18.00
Benzidine	lb.	1.80	1.90
Benzidine sulfate	lb.	1.60	1.70
Benzoic acid	lb.	5.50	8.00
Crude	lb.	3.00	3.50
From gum	lb.		7.50
Benzylchloride	lb.	2.25	2.50
Chloro benzene	lb.		.31
Cumidine	lb.	—	—
Diamido phenol	lb.	—	—
o-Dianisidine	lb.		
Dichloro benzene	lb.	.35	.40
o-Dichloro-benzene	lb.		
p-Dichloro-benzene	lb.	.21	.21
Diethyl-aniline	lb.	—	3.50
Dimethyl aniline	lb.	.60	.62
Dinitro benzene	lb.	.33	.35
m-Dinitro-benzene	lb.	.45	.50
Dinitrochloro-benzene	lb.	.50	.56
Dinitro naphthalene	lb.	.44	.75
Dinitro phenol	lb.	.67	.70
Dinitro toluene	lb.	.55	.60
Diphenylamine	lb.	.90	1.00
Dioxy naphthalene	lb.		
Ethyl aniline	lb.	1.00	1.25
Hydrazine sulfate	oz.		.80
Hydroquinone	lb.	2.55	2.62
Hydrazobenzene	lb.	1.50	2.00
Methylanthraquinone	lb.		—
Metanilic acid		—	—
Naphthalene diamine	lb.		
Naphthionic acid, white	lb.	1.50	1.80
a Naphthol	lb.		[illegible]
b Naphthol	lb.	.70	.75
Sublimed	lb.	[illegible]	.90
Naphthosulfonic acid		—	—
a Naphthylamine	lb.	1.15	1.25
b Naphthylamine	lb.	2.10	2.25
Sublimed	lb.	3.10	3.15
p-Nitraniline	lb.	1.25	1.35
Nitrobenzene	lb.	.20	.22
Oil of Mirbane, ref.	lb.	.18	.20

o-Nitrochloro-benzene	lb.	.50	.56
Nitro-naphthalene	lb.	.44	.65
Nitro-naphthol	lb.	—	—
Nitrotoluene	lb.	.60	.65
o-Nitrotoluene	lb.	—	1.00
p-Nitrotoluene	lb.	—	1.25
m-Phenylene-diamine	lb.	1.15	1.25
p-Phenylene-diamine	lb.	3.50	4.50
Phthalic acid	oz.	—	.60
Phthalic anhydride	lb.	6.40	6.50
Picric acid, kegs	lb.	.80	1.10
Pyrocatechin resublimed	oz.	—	.80
Resorcinol, cryst., U. S. P.	lb.	16.00	17.00
Technical	lb.	—	9.00
Salicylic acid, U. S. P.	lb.	.80	.85
Sulfanilic acid	lb.	.34	.35
Tetra-nitro-methyl-aniline	lb.	—	2.50
Tolidine	lb.	—	—
Toluidine	lb.	.80	.90
o-Toluidine	lb.	.90	1.00
o-Toluidine	lb.	1.85	2.00
m-Toluylene-diamine	lb.	1.70	1.75
Xylidine	lb.	.75	.80

SYNTHETIC MEDICINALS, FLAVORS AND PERFUMES.

Acetanilide C. P., bbls.	lb.	.44	.45
Acetphenetidine	lb.	24.00	24.50
Acetyl-salicylic acid, bulk	lb.	—	3.50
Ammonium benzoate	lb.	5.20	5.70
Ammonium salicylate	lb.	3.25	3.50
Antipyrine, bulk	lb.	19.75	20.25
Benzanilide	oz.	—	2.30
Benzonaphthol	lb.	16.00	18.00
Bismuth salicylate	lb.	—	3.15
Bismuth phenolsulfonate	lb.	—	9.30
Bismuth salicylate, 40 p.c.	lb.	—	4.75
Bismuth sub-benzoate	lb.	6.55	6.90
Bismuth subsalicylate, basic, U. S. P.	lb.	—	5.20
Caffeine benzoate	oz.	1.25	1.55
Caffeine salicylate	oz.	.90	1.00
Calcium benzoate	oz.	—	.40
Calcium salicylate	lb.	—	—
Calcium sulfocarbolate	lb.	1.42	1.45
Ethyl benzoate	lb.	—	8.00
Guaiacol salicylate	oz.	1.55	1.80
Lithium benzoate	lb.	8.00	8.25
Lithium salicylate	lb.	4.00	4.40
b Napthol benzoate	oz.	—	1.10
Phenacetin (Bayer)	oz.	—	2.40
Phenacetin (L. & F.)	oz.	—	2.10
Phenolphthalein	lb.	17.00	18.00
Potassium salicylate	lb.	3.00	3.25
Pyoktanin Blue	oz.	2.50	3.00
Pyramidone	oz.	—	2.50
Sodium benzoate, granulated, U. S. P.	lb.	4.25	4.50
Sodium salicylate, U. S. P.	lb.	—	.85
Strontium salicylate, U. S. P.	lb.	2.70	3.00
Saccharin	lb.	34.00	35.00
Salol, U. S. P.	lb.	—	1.50
Salipyrine	oz.	—	.80
Salol	lb.	1.95	2.05
Salophen	tube	1.50	1.80
Sulfocarbolic acid (30 p.c.)	oz.	—	.25
Sulfosalicylic acid	oz.	.65	.75
Tolypyrine	oz.	—	1.25
Triphenine	oz.	—	.50
Wintergreen oil synthetic, U. S. P.	lb.	.80	.90
Zinc salicylate	lb.	—	3.25

PHOTOGRAPHIC DEVELOPERS.

Adurol, 16 oz. bottles	ea	—	10.00
Agfa (intensifier) 2-oz. bottle		—	.40
Amidol 1-oz. bottle	oz.	.65	.75
Dianol 1-oz. bottle	oz.	—	.80
Edinol		—	—
Eikonogen	oz.	—	.45
Glycin, 1 oz. bottle	oz.	—	.80
Hydroquinone	lb.	2.00	2.10
Metacarbol		—	—
Metol	oz.	—	—
Monomethyl-p-amido-phenol (identical with metol)	oz.	—	3.50
Nerol (identical with amidol), 1 oz.	oz.	—	.30
Ortol, 1-oz. bottle	oz.	—	.80
Pyrogallic acid, crystals	lb.	2.95	3.15
Rhodol	lb.	—	—
Rodinal, 3-oz. bottle	ea.	—	.75

ARTIFICIAL COLORS.

Acid Black	lb.	1.10	1.75
Acid Blue	lb.	2.50	4.00
Acid Brown	lb.	1.25	1.50
Acid Fuchsine	lb.	7.00	10.00
Acid Green		1.75	6.50
Acid Orange	lb.	1.00	1.50
Acid Orange II	lb.	1.00	1.25
Acid Orange III	lb.	1.00	1.15
Acid Red	lb.	2.50	3.55
Acid Scarlet	lb.	2.30	3.50
Acid Yellow	lb.	2.00	3.00
Alizarin Blue	lb.	7.00	8.00
Alizarin Blue, bright	lb.	6.50	7.00
Alizarin Blue, medium	lb.	5.50	6.00
Alizarin Brown, conc.	lb.	8.50	10.00
Alizarin Orange	lb.	8.25	9.50
Alpine Red	lb.	6.75	8.00
Alpine Yellow	lb.	6.75	8.00
Auramine		5.50	7.50
Azo Carmine	lb.	5.50	6.00
Azo Yellow	lb.	2.60	3.00
Azo Yellow, red shade	lb.	4.50	5.00
Aurine	lb.	2.00	2.50
Bismarck Brown Y	lb.	1.10	1.30
Bismarck Brown FF conc	lb.	2.25	3.25
Bismarck Brown 3 R	lb.	1.60	2.00
Bismarck Brown R	lb.	1.30	2.00
Bright Red	lb.	2.75	3.75
Chrysamine Yellow	lb.	1.50	2.50
Chrysoidine	lb.	1.50	1.60
Chrysoidine R.	lb.	2.00	2.25
Chrysoidine Y	lb.	1.75	2.00
Congo Red	lb.	2.60	3.00
Crystal Violet	lb.	7.00	8.00
Direct Acid Orange	lb.	1.10	1.25
Direct Black	lb.	1.50	2.00
Direct Blue	lb.	2.60	3.00
Direct Sky Blue	lb.	2.50	3.50
Direct Brown	lb.	1.60	2.00
Direct Bordeaux	lb.	5.25	5.50
Direct Fast Red	lb.	2.10	2.50
Direct Red	lb.	2.50	4.00
Direct Yellow	lb.	2.50	3.50
Direct Fast Yellow	lb.	2.40	3.00
Direct Violet	lb.	3.50	4.50
Eosine		11.00	15.00
Fast Red, 6B extra	lb.	—	1.85
T extra	lb.	—	2.00
Fast Scarlet	lb.	1.75	2.35

Fuchsine		7.50	12.00
Fur Black, extra	lb.	3.50	4.50
Fur Brown B	lb.	3.00	6.00
Fur Brown GG	lb.	—	8.00
Green Crystals	lb.	7.50	8.50
Indigo 20 p.c. paste	lb.	1.50	1.60
Indigotin	lb.	3.85	4.00
Induline	lb.	1.30	1.60
Magenta	lb.	—	10.00
Malachite Green	lb.	11.00	12.00
Metanil Yellow	lb.	2.50	3.00
Medium Green	lb.	4.00	4.50
Methylene Blue, tech	lb.	4.50	5.00
Methyl Violet	lb.	4.00	4.75
Naphthol Green	lb.	3.50	3.75
Nigrosine, oil sol	lb.	.80	1.00
Nigrosine, sp. sol	lb.	.90	1.00
Nigrosine water sol., blue	lb.	1.60	2.00
Jet	lb.	1.35	1.50
Naphthol Green	lb.	4.50	6.00
Naphthylamine Red	lb.	6.00	6.50
Oil Black	lb.	—	1.25
Oil Green	lb.	2.00	2.50
Oil Orange	lb.	—	2.00
Oil Scarlet	lb.	2.50	3.00
Oil Yellow	lb.	1.80	2.50
Orange, RG	lb.	1.50	2.00
Orange Y, conc	lb.	1.10	1.50
Ponceau	lb.	2.50	3.00
Quinoline Yellow		5.00	6.00
Rbodamine		3.25	6.50
Saffranine		15.00	20.00
Scarlet 2 R	lb.	2.00	5.00
Soluble Blue	lb.	6.50	8.50
Sulfur Black	lb.	.75	.95
Sulfur Black 150 p.c	lb.	—	.85
Sulfur Blue	lb.	2.60	3.25
Sulfur Blue-Black	lb.	4.00	4.20
Sulfur Brown	lb.	.28	.50
Sulfur Green	lb.	1.60	1.75
Sulfur Yellow	lb.	—	—
Tartrazine	lb.	1.90	2.00
Wool Orange	lb.	1.50	2.00
Victoria Blue	lb.	16.00	18.00
Victoria Blue, base	lb.	23.00	24.00
Victoria Green	lb.	12.00	13.00
Victoria Red	lb.	6.00	7.00
Victoria Yellow	lb.	7.50	8.00
Yellow for wool	lb.	2.75	3.00

NATURAL DYESTUFFS.

Annatto, fine	lb.	.35	.36
Seed	lb.	.15	.17
Carmine No. 40	lb.	4.25	4.75
Cochineal	lb.	.53	.58
Indigo, Bengal	lb.	3.50	4.50
Oudes	lb.	3.00	3.25
Guatemala	lb.	2.35	2.65
Kurpahs	lb.	3.15	3.60
Madras	lb.	1.15	1.25
Madder, Dutch	lb.	.27	.29
Nutgalls, blue Aleppo	lb.	—	—
Chinese	lb.	.25	.26
Persian Berries	lb.	—	—
Turmeric, Madras	lb.	.08½	.09
Aleppey	lb.	.10	.10½
Pubna	lb.	—	—
China	lb.	.07	.07½

DYEWOODS AND RAW MATERIALS.

Algarobilla	ton	140.00	150.00
Barwood	lb.	—	—
Camwood, chips	lb.	.17	.20
Divi-Divi	ton	61.00	62.00
Fustic, sticks	ton	39.00	40.00
Chips	lb.	.04	.05
Hypernic, chips	lb.	.09	.10
Logwood sticks	ton	39.50	40.00
Chips	lb.	.03	.04½
Myrobolans	ton	60.00	65.00
Quercitron Bark No. 1	ton	—	50.00
No. 2	ton	—	28.00
Red Saunders, chips	lb.	.15	.17
Sumac, Sicily, 27 p.c tannin	ton	85.00	95.00
Virginia, 20 p.c. tannin	ton	55.00	57.00

EXTRACTS.

Archil, double	lb.	.14¼	.16¼
Triple	lb.	.18½	.19½
Concentrated	lb.	.28¼	.30¼
Chestnut, 25 p.c. tannin	lb.	.02¼	.02¾
Clarified, 25 p.c. tannin	lb.	.02½	.03
Cutch, Rangoon, boxes	lb.	.12½	.13½
Liquid	lb.	.08½	.09
Tablet	lb.	.10	.12
Cubear, French	lb.	—	—
English	lb.	.21	.27
Concentrated	lb.	—	.38
Flavine	lb.	1.00	1.50
Fustic	lb.	.11	.12
Gall	lb.	—	.18
Gambier, 25 p.c. tannin	lb.	.10	.10½
Common	lb.	.15½	.16
Cubes No. 1	lb.	.23	.24
No. 2	lb.	.21	.22
Hematine	lb.	.08	.10
Crystals	lb.	.20	.26
Hypernic, liquid	lb.	.18	.20
Indigo, natural for cotton	lb.	.50	.52
For wool	lb.	.28	.31
Indigotin, 100 p.c. pure	lb.	—	5.50
Logwood, solid	lb.	—	.17
Crystals	lb.	.19	.24
51° Tw.	lb.	.08	.10
Myrabolans, 25 p.c. tannin	lb.	.06	.07
Solid, 50 p.c. tannin	lb.	.10	.11
Osage Orange—			
Powdered, Aurantine	lb.	—	.25
Paste	lb.	.06	.12
Persian Berries	lb.	—	—
Quercitron	lb.	.05	.07
Sumac, liquid, 25 p.c. tan	lb.	.06	.10½

DYEING ACCESSORIES.

Acetic acid, 28 p.c	lb.	.06	—
56 p.c.	lb.	.10	.12
Glacial, 99 p.c	lb.	.33	.35
Albumen, Egg	lb.	.80	.85
Blood, imported	lb.	.46	.50
Domestic	lb.	.36	.45
Alum, ammonium, lump	lb.	.04½	.05
Alum, chrome ammonium	lb.	.18	.18½
Alum, chrome potassium	lb.	.40	.45
Alum, chrome sodium	lb.	.12½	.13
Alum, potassium, lump	lb.	.06½	.07
Aluminum acetate	lb.	.70	.80
Aluminum chloride, cryst	lb.	.90	1.00
Aluminum sulfate, techn	lb.	.02	.02⅛
Aluminum sulfate, iron free	lb.	.03½	.03¼
Ammonium vanadate	lb.	7.00	—
Borax, cryst.	lb.	.08	.08⅛
Citric acid, crystals	lb.	.72	.72½
Powdered	lb.	.72½	.73
Copper acetate (verdigris)	lb.	.90	1.15
Copper sulfate (blue vitriol) 99 p.c.	lb.	.09½	.10
Dextrine, corn	100 lbs.	6.05	6.10
Dextrine, imported potato	lb.	.12	.13
Dextrine, domestic potato	lb.	.12½	.13
Ferric sulfate, basic (nitrate of iron), comm.	lb.	.02½	.03
True		.05	.06
Ferrous acetate (pyrolignite)	lb.	—	—
Ferrous sulfate (copperas)	100 lb.	1.05	1.10
Formic acid, 75 p.c	lb.	.35	.40
Glauber's salt (sodium sulfate)	100 lb.	.65	.70
Glucose	100 lb.	2.50	2.55
Glycerin, C. P	lb.	.60	.60½
Gum arabic, firsts	lb.	.43	.45
Seconds	lb.	.40	.42
Sorts, amber	lb.	.20	.21
White	lb.	.35	.38
Gum tragacanth, Alep., firsts	lb.	2.30	2.35
Seconds	lb.	1.95	2.05
Thirds	lb.	1.65	1.80
Sorts	lb.	.75	.90
Hydrochloric acid (muriatic) 18°	lb.	.01¼	.01½
20°	lb.	.01½	.01¾
22°	lb.	.01¾	.02
Lactic acid, 22°	lb.	.05	.06
44°	lb.	.12	.13
Nitric acid, 36°	lb.	.05¾	.06¼
38°	lb.	.06	.06½
40°	lb.	.06¾	.07
42°	lb.	.07½	.08
Oxalic acid	lb.	.46	.47
Potassium antimony tartrate (tartar emetic)	lb.	.57	.58
U. S. P.	lb.	.62	.65
Potassium bichromate	lb.	.36	.37
Potassium ferricyanide (red prussiate)	lb.	2.60	2.80
Potassium ferrocyanide (yellow prussiate)	lb.	.96	1.05
Potassium tartrate, acid (cream of tartar)	lb.	.48½	.49
Prussian blue	lb.	.80	.90
Soluble	lb.	.95	1.00
Sago flour	lb.	.04¾	.05
Soda ash, 58 p.c.	100 lbs.	2.85	3.25
Soda, caustic, 76-78 p.c.	100 lbs.	6.00	6.75
Sodium acetate	lb.	.09½	.10
Sodium arsenate	lb.	.25	.60
Sodium bichromate	lb.	.15½	.16
Sodium bisulfite	lb.	.05½	.05¾
Sodium chlorate	lb.	.25	.26
Sodium ferrocyanide (yellow prussiate)	lb.	.30	.34
Sodium nitrite techn.	lb.	.32	.38
U. S. P.	lb.	.36	.40
Sodium phosphate, com.	lb.	.06	.07
Sodium silicate, liquor 40° Bé.,	100 lbs.	1.25	1.50
Crystals	lb.	.02¼	.02½
Sodium sulfide, 60 p.c., fused	lb.	.03	.03¼
Crystals, 30 p.c.	lb.	.02	.02¼
Sodium Thiosulfate (hyposulfite)	100 lbs.	1.75	2.00
Soluble oil, 50 p.c.	lb.	.10	.12
75-85 p.c.	lb.	.14	.16
Stannous chloride (tin crystals),	lb.	.37½	.38
Stannic chloride (tin bichloride), 50°	100 lbs.	17.50	18.00
Starch, corn, pearl	100 lbs.	4.95	4.99
Potato	lb.	.12½	.13
Rice	lb.	.08	.10
Wheat	lb.	.05	.06
Sulfuric acid, 60°	ton	24.00	26.00
66°	ton	31.00	35.00
Oleum, 20 p.c.	ton	40.00	42.00
Tartaric acid, crystals	lb.	.78½	.82
Turkey Red oil	lb.	.14	.25
Zinc dust, 350 mesh	lb.	.19	.20

DYE NOTES

Cadmium Derivatives of Acridine Dyestuffs for Use as Bactericides.

Dr. Paul Hussy and Dr. Max Hartmann, of Basel, Switzerland, find that cadmium derivatives of various acridine colors possess as marked bactericidal properties, as the corresponding silver compounds. The method used for their preparation (Amer. Pat. 1,228,926, of June 5, 1917), is much similar to that employed in making the latter.

The various dyes of the acridine series or of their derivatives, obtained by alkylating the acridine nitrogen, are dissolved in either alcohol, pure water, or in water acidulated with hydrochloric acid. Concentrated solutions of cadmium chloride are added, and the new cadmium compounds crystalize out. They are of a reddish brownish color, and are soluble in water with reddish-brown or yellow, orange colorations, and in alcohol or sulfuric acid with green fluorescence.

Even when greatly diluted, these solutions act strongly upon bacteria, checking farther growth.

British Profits in the Artificial Color Industry.

Levinstein, Ltd., one of the leading British companies engaged in the manufacture of coal-tar colors, has declared an interim dividend of 15 per cent. on the account for 1917. For 1916, the dividend was 30 per cent.

To Manufacture Colors and Dyestuffs.

Zobel, Stern & Campbell, Inc., has been chartered to manufacture colors and dyestuffs, with a capital of $20,000, by H. E. Zobel, G. M. Campbell and B. F. Meyer, 253 Brooklyn, N. Y.

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By Carleton Ellis and A. A. Wells[*]

This Is the Fourth Installment of an Article Dealing with Investigations Conducted by the Writers Into the Possible Applications of Ultra Violet Light. The Present Installment Discusses the Work of Other Investigators in Connection with the Action of Its Rays on Organic Acids Containing Halogens and on Plants, Seeds, etc. The Physiological and Therapeutic Effects of the Light Are Also Discussed, Together with the Effects of Its Rays on the Eye. Part V Will Appear in the Next Issue.

PART IV.

Magnesium Sulphide.

All pure preparations of *magnesium sulphide* examined by *Tiede* (Ber. 49, 1745) when exposed for a few seconds to day or arc light became faintly luminous. The crude product was more faintly phosphorescent than the pure material. Magnesium sulphide is much more sensitive to long wave lengths. No excitation was observed with radium or Roentgen rays or in the light of the ultraviolet lamp. When exposed to direct cathode rays it shows lively blue or red fluorescence and a feeble afterglow.

Chlorine and Hydrogen.

The temperature coefficient of the photochemical action of monochromatic light on a mixture of *chlorine* and *hydrogen* has been investigated by *Padoa* and *Butironi* (Chem. Abs. 1356, 1917, Att. accad. Lincei. 24, II, 215-8 (1916). The results of experiments on the variability of the temperature coefficient of the reaction velocity of photochemical processes with changes in the wave length of the light used, have made desirable a similar study of simple photochemical reactions in which there can be no doubt that the reaction is purely photochemical. The reaction of hydrogen and chlorine in the presence of light fulfills these requirements. Favre and Silbermann (Ann. chim. phys. (3) 37, 297) found that different parts of the spectrum produced a catalysis of varying intensity. Bunsen and Roscoe found a miximum intensity of action between 413 and 395 uu. Bevan's experiments (Proc. Camb. Phil. Soc. 12, 398) showed that the temperature influences the velocity of this reaction and Kastle and Beatty (Am Chem J. 20, 159-63) found that at 120° the velocity of reaction is zero. Bunsen and Roscoe devised an actinometer for the study of this reaction, a modified form of which was used by Padoa. It was so constructed that the gas bulb could be kept in a thermostat with glass walls. The apparatus was mounted in a camera obscura and the source of light at once side was in a box provided with a hole, through which the beam to be studied was admitted to the bulb. Ultraviolet light was obtained from a mercury lamp. It was observed that the acceleration produced by increases of temperature is small for the ultraviolet light, is greater for violet and blue light and is maximum for green; for white light it is intermediate. The temperature coefficients when calculated bring this out still better, for white the coefficient is 1.29; for green (550-530) 1.50; for blue, (490-470) 1.31; for violet (460-440) 1.21; for ultraviolet (400-350) 1.17.

Organic Acids Containing Halogens.

The photochemical reactions between *bromacetic acid* and alcohol and between *chloracetic acid* and alcohol have been studied by *Cassel* (Z. physik. Chem. 92, 113-26 (1916)). The reactions were carried out in a transparent quartz vessel which was illuminated by an arc lamp of 1800 candle power. It has been found that decomposition into methyl alcohol, acetic aldehyde and the halogen acid occurs. The reaction is only sensitive to ultraviolet rays of a wave length of less than 250 uu. It has been observed that the bromine compound is more easily decomposed by alcohol both in the light and in the dark than the chlorine compound. In aqueous solution the halogen has been found to split off from 1-*bromosuccinic* acid more readily in the light than 1-*chlorosuccinic* acid in a corresponding solution.

Euler (Ber. 49, 1366-71 [1916]) has stated that when haloacetic acids in dilute water solution are exposed to the ultraviolet rays of a mercury lamp, halogen is split off at 18° with a velocity corresponding to that attained when the non-illuminated solutions are heated to about 100°. The light reaction differs from that in the dark in being of a lower order, increasingly smaller amounts of the halogen compounds decomposing per unit of time as the concentration increases. The reaction seemed to be well adapted to answering a question of importance from the photochemical standpoint, namely, whether illumination before the photochemical decomposition produces a loosening of the atomic unions in the molecule; specifically, whether a considerable part of the light-sensitive chloracetic acid possesses after the illumination an atomic grouping still corresponding to the usual formula for the acid but characterized by greater liability of reactivity in reaction in the dark. In flat quartz vessels 0.5 N solutions of dry chloracetic acid in benzene kept at 27° (under these conditions no measurable amount of chlorine is split off without illumination in the time intervals used) were exposed, at a distance of seven centimeters to the light of a Heraeus quartz mercury lamp; after 150 minutes five cubic centimeters of the solution were shaken with ten cubic centimeters of 0.5 N caustic soda, heated exactly thirty minutes at 70°, quickly cooled, freed from benzene, acidified with nitric acid, treated with silver nitrate at room temperature and the silver chloride determined in the usual way after standing a long time. Parallel determinations with unilluminated solutions were made simultaneously. The illuminated solutions gave 0.0328 grms. silver chloride, the non-illuminated one 0.0272 grms. That the excess in the first case (0.0022 grms. per hour illumination) was split off during the illumination, although the solvent was benzene was shown by precipitating the sliver chloride immediately after shaking the solution with caustic soda; the illuminated solution gave the same amount of silver chloride (0.0024 grms.) per hour, the non-illuminated one none; this, in conjunction with the first experiments also shows that the part of chloracetic acid undecomposed by illumination is decomposed by caustic soda with the same velocity as the non-illuminated chloracetic acid. To determine the nature of the decomposition produced by the light, large amounts of the illuminated solutions in benzene were shaken out with alkali, acidfied with sulphuric acid, freed from most of the chloracetic acid by steam distillation, extracted with ether, dried, evaporated and treated with chloroform to remove the rest of the chloracetic acid; the residue heated to 200-50° gave a sublimate of fumaric acid. The presence of an unsaturated acid was also detected by the behavior of the alkaline extract of the reaction solution towards dilute potassium permanganate, 3.5 cubic centimeters of a 0.01 N solution of which was decolorized by 5 cubic centimeters of a 0.5 N solution chloracetic acid in benzene, illuminated 4 hours. If the illuminated solution is shaken, with water (instead of caustic soda) until nearly all the acid is removed, then treated with chloroform and again shaken with water, the dried benzene-chloroform extract yields glycolide melting at 82°. Shaking the benzene with alkali also yields a small amount of polyglycolide. From the solubility relations of fumaric acid it appears that another unsaturated acid more soluble in benzene, ether, and chloroform is also formed. In ether instead of benzene the results are qualitatively the same but more chlorine split off (corresponding to 0.006 grms. silver chloride per hour illumination.) In water solution the difference between the decomposition velocity of the undissociated acid and the chloracetic acid is smaller in the light than in the dark. In benzene, bromacetic acid is decomposed more quickly than chloracetic acid contrary to what occurs in water solution in the light, but in agreement with the results obtained in the dark. (Chem. Abs., 1917-942).

---

[*] All rights of publication in book form reserved by the authors, Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

Salts of Phthalic Acid.

In the course of some investigations on the salts of phthalic acid, which were carried out by *Ekely* and *Banta* (J. Amer. Chem. Soc., 1917, 762), lead phthalate was exposed in a small quartz crucible to the action of light from a quartz mercury vapor lamp. The outside layer of the salt decomposed rapidly with the formation of a yellowish brown substance of unknown composition, probably containing lead oxide. A similar experiment performed with *mercuric phthalate* showed the salt to be unaffected.

Sugar Synthesis.

Stoklasa notes that formic acid and not carbon dioxide and water was first produced by the action of ultraviolet rays on *formaldehyde* in the presence of caustic potash with access of air or oxygen. The formic acid was then decomposed into carbon dioxide and water. *Hexoses* (yielding a phenylosazone with m. p. 204-5°) were produced by the action of ultraviolet rays on carbon dioxide and caustic potash in the presence of ferrous compounds. No formaldehyde was formed from carbon dioxide (or acid potassium carbonate) and water under the influence of utraviolet rays. The carbohydrates produced during photosynthesis consisted of a mixture of hexoses (aldoses and ketoses) or their osazones. This synthetic sugar was not decomposed by Saccharomyces. Sugar synthesis can also proceed with the action of nascent hydrogen. A general survey of the literature is given by Stoklaša. (Zentr. Biochem. Biophys, 18, 370)

Cellulose.

It has been claimed by Witz that the action of light on *cellulose* produces oxycellulose, while Girard has asserted that the product is more probably hydrocellulose. To throw some light on this moot point *Dorée* and *Dyer* (J. Soc. Dyer's Colourists 33, 17-9, 1917; Chem. Abs., 1917, 1753) exposed some specially scoured and bleached cotton cloth to the rays of the Cooper-Hewitt mercury vapor lamp continuously for a period of one week and then tested the exposed cloth in various ways. The results of their experiments are tabulated and the conclusion is drawn that utraviolet light under the conditions employed converts cellulose with complete loss of tensile strength into an oxycellulose.

Flour.

Ultra violet radiation has been suggested in the treatment of flour with axidizing agents. The process of the *Naamlooze Vennootschap Industrielle Maatschappij Voorheen Noury and Van Der Lande* employs a peroxide (British Patent 102,967, Dec. 22, 1915; Chem. Abs., 1917, 1219). Flour or meal is mixed with a small quantity of an inorganic or organic peroxide and then subjected to a physical or chemical treatment to decompose the peroxide. In an example, bolted flour is mixed with 0.7% of a solution of hydrogen peroxide of 3% strength, and then passed in a layer 3 cm. thick on a belt conveyer, through a room in which mercury vapor lamps are situated.

Protein.

The action of ultraviolet rays on *egg* and *serum proteins* has been found by Schanz (Arch. ges. Physiol. 164, 445-56, 1916; Chem. Zentr. 1916, II, 670-1; Chem. Abs., 1916, 1656) to bring about a considerable degree of modification. In alkaline solution the amount of bodies precipitated by ammonium sulphate and sodium chloride was decreased, while in acid solution, the amount precipitated was increased. The change produced by light is stated to be regarded as a gelatinization of the proteins. This action is increased by the presence of oxygen.

Action of the Rays on Seeds and Plants.

De Wolf and *Fry* (British Patent 23,339, Oct. 15, 1913) propose the treating of *seeds,* by subjecting them before sowing, to the action of ultraviolet rays from a mercury vapor or other electric lamp, with or without previous treatment with water or a solution of sodium nitrate or other manure. The seeds are placed in a tank having a cover which rises towards the center, the lamp rests in an aperture. The seeds are stirred by means of rakes introduced through openings at the ends of the lid, which are covered by a dark cloth. The lamp may be immersed in the liquid such as a dilute nitric acid solution in which the seeds are placed.

Pouget (Comptes. rend., 1911, 1184) notes that after exposure to the action of ultra violet rays, green *vanilla pods* yielded a distinct odor of vanillin, while similar pods protected from the rays gave no odor. The odor was perceptible after 2 hours exposure at a temperature of 68° C., or after 6 hours at 37° C. The development of the odor was accelerated by first immersing the pods in a very dilute solution of manganous-chloride.

Pouget (Comptes. rend., 1910, 151, 355) exposed certain plants containing *coumarin,* to the ultraviolet rays emitted by a quartz mercury vapor lamp (using 4 amperes at 110 volts). After a few minutes the odor of coumarin became perceptible. Other plants containing a water soluble glucoside, such as the cherry laurel, also developed an odor after a few minutes exposure to the rays. It appears that the cell is killed, while the enzymes survive. The action of the rays on these plants resembles that of anaesthetics.

Colloidal solutions obtained by extracting the seeds of plantago psyllium L., with water have been examined by *Gutbier* and *Huber* (Kolloid. Z. 1916, 19, 90; J. Chem. Soc. II 556-7) with special reference to the phenomena of ageing and the effects produced by the addition of electrolytes and the action of ultraviolet light.

Chlorophyll.

In experiments to show the significance of the action of ultraviolet rays on the photochemical synthesis of carbohydrates in cells containing chlorophyll, *Stoklasa* (Strahlentherepie 6, 119-72, 1915, Zentr. Biochem. Biophys. 18, 370-1, 1915) observed that after irradiation the young leaves of etiolated seedling of Pismu, Zea mais, Avena and Hordeum showed a dark green coloration in two hours, while solor radiation caused a similar color only after six hours exposure. Longer exposure did not injure the cell plasma. The cells of flowers, as well as those of plants grown under glass, were, however, more sensitive toward ultraviolet rays than the cells of green leaves. Crude chlorophyll in alcoholic solution was not decomposed by the action of ultraviolet rays during an exposure period of 5-60 minutes.

THE PHYSIOLOGICAL AND THERAPEUTIC EFFECTS OF ULTRAVIOLET LIGHT.

For the sake of completeness, a few details of the application of ultra violet light to the human body for remedial purposes have been added to this article. The authors realize that they may be open to criticism for presenting this matter in the columns of a journal devoted to chemical engineering. Our only apology for the inclusion of this material is that usually the first inquiry made by those who are starting out to investigate ultraviolet light and study its chemical activities has related to the physiological effects of this form of energy. Many rumors are extant concerning the severe effects of ultraviolet light and the more timid investigator is likely to work under misapprehension regarding the action of these rays on the human body. Reasonable precaution should of course be taken, but it is not necessary to resort to some of the protective measures which have been recommended by those insufficiently familiar with the action of the ultraviolet light in this respect. The citation of the manner of treatment by physicians of a number of cases in which ultraviolet light has been employed gives an idea of the action of the light under various conditions and is therefore more satisfying than any general statement of the effects produced. From this standpoint the following matter is of value to the engineer or chemist beginning experiments with ultraviolet light and in this aspect should not be considered irrelevant.

A type of ultraviolet lamp suited for therapeutic uses together with its method of operation, also some of the results obtained are described by Bach (Ultraviolet Light, published by Paul B. Hoeber, N. Y., 1916).

According to Bach, Finsen attributed his success with light treatment of certain local affections to the ultraviolet side of the spectrum. But the arc light used by the latter contained but few ultraviolet rays, and consequently the duration of the treatment was very much prolonged, and small surfaces only could be treated at any one time. The therapeutic quartz lamp (introduced in 1907 by the Quartzlampen Gesellschaft of Hanau, Germany, now made in the United States by the Hanovia Chemical & Manufacturing Co., Newark, N. J.), was used at first almost exclusively in surgery and in skin diseases, that is, local affections in the manner employed by Finsen. Later, after improvements by Kromayer it became most useful in this field. However, only in the last few years have the ultraviolet rays been employed in general treatment. A few affections such as inflammations of the skin which occurred in a number of metal works were thought to be caused by ultraviolet rays and this belief served for some time to deter their application in a general way.

Rollier and others found that sun baths, especially at great altitudes, such as in the Alps, were beneficial in the treatment of diseases of the nature of tuberculosis (especially of the bones and the joints). These results were considered due to an abundance of ultraviolet rays in the sun's rays at these altitudes. As the ultraviolet rays of sunlight are largely absorbed in passage through the atmosphere, the value of ultraviolet rays in the sun bath treatment was long doubted. In fact, in 1903, Rieder made the assertion that the medium or red heat ray was the controlling factor in the beneficial effects of the sun bath. The quartz lamp has afforded a means of studying the effects of ultraviolet rays upon the human body in general treatment, with the result that a considerable amount of data has already accumulated on this subject.

Two types of lamp are used in the treatment of diseases, the so-called "sun lamp" for general application or for the treatment of large areas and the Kromayer apparatus for local applications. The "sun lamp" consists of a quartz burner from two and one-half to five inches in length, mounted in an aluminum reflector, which in some cases is fitted with a shutter by means of which the area of the surface to be exposed to the ultraviolet rays may be controlled. On either or both ends as the case may be, the burner is fitted with strips of metal which are spread out fan-like, to serve as heat conductors and thus to control the temperature of the lamp.

The burner and reflector are adjustably mounted either on a stand or rope support. A rheostat forms a part of the equipment. The burners are made for 90-120 volts and 200-240 volts direct current. In case alternating current only is available a current rectifier or a motor generator set may be used. A form of lamp used by physicians is shown in Fig. 1.

The Kromayer lamp consists of a quartz burner about one-fourth inch in diameter, bent in the shape of a U. About one-third of the U portion is bent at right angles to the main portion and when in operation is inverted, so that the arc is drawn in this portion of the tube. The burner is placed in a water-cooled casing, which has a quartz lens for the emission of the light. This equipment is mounted on a stand in a manner which admits of free adjustment. In some cases blue filters are used to cut out the long heat and the very short ultraviolet rays.

A modification of the "sun lamp" is equipped with a ring of incandescent lamps surrounding the reflector of the mercury vapor lamp. These radiate heat and tend to counteract the coldness experienced by some persons during treatment, especially when protracted. The effect of this form of treatment is more like a natural sun bath.

Bach recommends that the eyes should be protected by the use of goggles or of a dark cloth, as ultraviolet rays may cause a painful inflammation of the conjunctiva. The light which is reflected from bright surfaces after a long exposure may cause conjunctivitis or an uncomfortable irritation of the eyes.

It is claimed, however, that ultraviolet light is not permanently injurious to the eyes, even in the case of abuse, any inflammation of the conjunctiva that may occur healing in a few days without special treatment. Burning of the skin by the ultraviolet rays also is stated not to result in any lasting injury. Individuals vary considerably in their resistance to the effect of the rays and the ultraviolet light therefore should not be used indiscriminately.

When starting treatment with ultraviolet rays, there is a feeling of warmth, later a slight tingling is experienced and by strong radiation burning of the skin results. This effect usually disappears in two or three days. In one case reported to the authors, an irritation of the skin persisted for a long period after only a moderate exposure. There is no visible change during the treatment of dry lesions, but moist surfaces such as bleeding or secreting wounds begin to dry up after a few minutes exposure. Usually in two to four hours after a treatment, redness appears on the part which has been exposed. The erythema persists for two or three days and is followed by a tan. Moist surfaces which have been dried by the effect of the light remain dry. During the first "general" treatment, that is, exposure of large area, there is no visible change, or merely a slight reddening. In three or four hours if the radiation has been very strong, the exposed surface shows a decided redness, and blisters may develop. The redness decreases gradually and within two or three days some pigmentation appears. Owing to the darkening of the skin thus produced, subsequent treatments are not usually accompanied by further reddening or blistering of the skin but there is increased tanning. If, however, the intervals between treatments are unduly long, or the treatment is very severe, the effect may be the same as resulting from the first treatment.

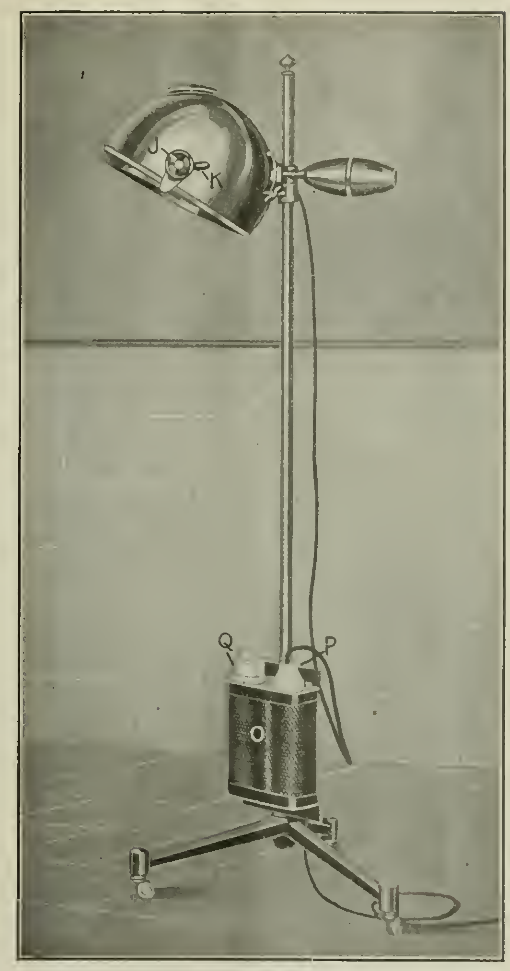


Figure 1. Type of Ultraviolet Lamp Used by Physicians.
(Courtesy Hanovia Chem. and Manf. Co.)

Injuries, even in the case of very strong exposure, are considered hardly possible, as ultraviolet rays do not penetrate more than one-fiftieth of an inch into the skin; merely penetrating into the uppermost layer of the epithelium. Blisters are stated to heal invariably without leaving scars.

To ascertain the effect upon the skin, eyes, and general condition, Bach resorted to a heroic test. He applied the ultraviolet light with great intensity upon his own person, without protecting his eyes. An exposure of thirty minutes was given at a distance of 16-20 inches from a 3,000 candle-power lamp. The head and body were treated alternately. After three minutes there was a sensation of warmth and after ten minutes a burning sensation at the place of exposure. An intense reddening appeared in two or three hours after the treatment. This coloration disappeared in three days There was no blistering, but the epidermis became dry and hard, and peeled off within a week, being replaced by a new epidermis which was elastic and brown. The conjunctiva commenced to redden in about two hours after the treatment, becoming inflamed and painful, but the inflammation disappeared in about three days without treatment. Immediately after the treatment and for days thereafter there was a feeling of freshness and of increased energy. This effect perhaps may be expressed as a case of over-stimulation of a person in good health.

A number of cases are reported by Bach, several of which are here noted to illustrate some of the classes of maladies treated by ultraviolet light.

In one case, a woman, forty-five years old, anaemic, with a thin, pale, and very sensitive skin, was treated on the back for three minutes at a distance of twenty inches from a 1,500 candle-power ultraviolet lamp. Two or three hours afterwards the whole body appeared red, including the unexposed parts. The reaction was so intense that the patient had to remain in bed. After three days the reddening, itching, and burning began to disappear, and although there was no blistering, the skin peeled off and was slightly browned. During this time there was a slight feeling of excitement, followed by a sensation of freshness, which lasted for days, after which the anaemia noticeably improved. This result shows that in cases of a sensitive skin, treatment should be commenced very gradually.

In another case, a man, thirty-five years old, who was inclined to congestion and headache, was given a treatment over head, breast, and abdomen for six minutes, at a distance of forty inches from a 3,000 candle-power ultraviolet light. After three minutes treatment, congestion in the head and ringing in the ears appeared, which disappeared on taking the patient into the open air. For two days after the treatment, he had headache, but afterwards felt better and fresher than before. Subsequent treatments given with the head covered were without ill effects and had a good effect upon the tendency to con-head and of headache, the head itself should not be ex-gestion. It is stated that in cases of congestion in the posed to the ultraviolet rays.

In another instance, a man, thirty-four years of age, who was in a state of advanced pulmonary tuberculosis, received regular treatments two or three times a week for one year. Exposures as great as thirty minutes at a distance of twelve to twenty inches from a 1,500 candle-power ultraviolet lamp were given. The treatments were often so severe that blisters were formed, the skin became very brown and peeled repeatedly. Since this treatment hemorrhages have ceased and general health has greatly improved.

A badly infected wound was treated by Bach daily for three days over a period of from five to ten minutes at a distance of sixteen inches from an ultraviolet lamp. The first treatment arrested the hemorrhage and the wound healed without further complications.

Schaer has successfully treated burns by a few exposures with the ultraviolet rays. Philip has observed that the use of the ultraviolet light alone causes a complete disappearance of eczema. Bach claims to be obtained permanent improvement in a considerable number of cases of heart trouble by treatment with the ultraviolet rays, but in order to accomplish this result he states the radiation employed was so severe as to produce hyperaemia of the skin with subsequent pigmentation. After each application the pulse became fuller and slower, and the breathing easier. In most cases the relief of the heart was noticeable even during the treatment and the patients themselves became conscious of improved respiration. Ostermann obtained excellent results with the ultraviolet lamp in the treatment of cases of hypersecretion and hyperacidity. Even very severe cases were benefited. After two or three treatments together with dietic measures, which alone had formerly been much less effective, unpleasant symptoms disappeared, the appetite improved and the weight increased. Siemon has reported (Munchener Medizinische Wochenschrift 48, 1914) on the use of quartz light in tetanus. Bach has cured a suppurating gunshot wound by three treatments with ultraviolet light, and numerous reports have been received from army surgeons telling of excellent results obtained in the treatment of wounds, and of nervous affections.

The successful use of the ultraviolet light in treating wounds, nervous affections, rheumatism, gout and anaemic conditions is of special interest at the present time because of the possibilities of application to good advantage in the care of wounded and sick soldiers.

At a private interview which one of the writers of this paper had with Dr. Donald McCaskey of 24 West 59th Street, New York, Dr. McCaskey stated that he is using ultraviolet light with marked success and he predicts that in the future its therapeutic uses will undoubtedly be still wider. Therapeutically, the use of ultraviolet rays is still in the experimental stage, and no fixed rules for its use, such as dosages to be given to certain patients are available. McCaskey states, however, that he hopes to be able to work out some method by which he may be able to tell by preliminary examination just how to treat a patient, that is, what the time of exposure should be and at what distance from the patient the light should be placed. Ultraviolet light he says is not a specific except perhaps in conditions due to infection or cases such as carbuncles or other types of pus formation, but the light is a very valuable adjunct when accompanied by internal chemical adjustment of the nitrogen balance.

A number of cases of various kinds have been treated successfully by McCaskey and a few of the typical ones are briefly described.

A severe case of lobar pneumonia in which both lobes of the left lung were practically filled, temperature 104, respiration 42, blood pressure 210. The patient was given a severe ultraviolet light treatment on chest and back. After twelve hours a change was noted, the blood pressure, respiration and temperature dropped, becoming quite normal after three days.

A case of chronic arthritis in which the patient had been able to move the elbow only slightly. After a few weeks of treatment with ultraviolet light in conjunction with internal nitrogen adjustment, the patient regained practically complete control of the affected parts.

In cases of boils, abcesses and even carbuncles three or four days serve to completely remove the pus, when healing is normal and rapid. McCaskey's method of treating these cases is as follows: The inflamed part is given a severe treatment, for example, by touching the affected region with the lamp container or attachment, and giving an exposure sufficient to just avoid causing a blister. The surrounding tissues are then given a slight treatment with the light. After the incision is made, the light is inserted in the wound and the latter given a thorough treatment. The spine is also given an exposure.

In prolonged treatments as in the case of malnutrition, McCaskey gives the first exposure for from three to five minutes at a distance of from eight to fourteen inches. No second treatment is given until the effects of the resulting ultraviolet light burn have disappeared and peeling of the skin is completed. After a complete new skin has formed, exposures of about ten minutes at a distance of about six inches are given.

McCaskey relates an interesting experience he had some time ago. He was holding a conversation with a man who was given to drunkenness. This man stated that he would give up drinking if McCaskey would give him a substitute. The patient's boast was promptly taken up. He was given a severe treatment with ultraviolet light on back and chest, producing blisters. The man was given an internal treatment to remove the poisons from his system and put to bed. For two or three days the severe burn and blisters kept his mind occupied so that liquor became a secondary thought. A general internal treatment together with applications of ultraviolet light were given to build up the system. The vitality gains were remarkable, and the appetite for drink disappeared.

In the treatment of the scalp, it has been McCaskey's experience that in case the root follicles are still living, hair can be restored, by giving rather intense exposures of the scalp to the ultraviolet rays. One instance was cited in which after several months treatment a normal growth has been obtained on a patient who had completely lost his hair. In this connection it was noted that the scalp does not become accustomed to the effect of the rays and that it is practically as easy to cause a burn after a prolonged period of treatment as at the first exposure. McCaskey states that this is not an especially popular remedy, inasmuch as the treatments must be severe to obtain results, and as stated above, the scalp does not become accustomed to the treatment.

It is quite commonly supposed that exposures to the ultraviolet rays cause permanent injury to the eyes unless properly protected. This is said to be a fallacy by McCaskey, who states that both he and his nurses work about the light, at times not even wearing goggles and that no injury has occurred. The conjunctiva is affected to a greater or lesser degree, depending upon the individual and upon the strength of the light, the length of exposure, etc., but on removal from the radiation the irritated conjunctiva soon becomes normal. By exposure, day after day, the eye becomes somewhat accustomed to the light and is not so readily affected as at first, the conjunctiva cells not having the power to fortify themselves against the action of the rays, similar to the protective effect resulting from tanning of the skin. McCaskey does not use eye shields with his patients, it being sufficient in most cases for the patient merely to close the eyes. In the case of specially light-sensitive persons it may be necessary for the patient to place the fingers over the eyes as further protection.

To summarize, therefore, ultraviolet ray treatments have been found beneficial in therapeutics, although the work is still in the experimental stage. The ultraviolet ray is not a specific except perhaps in the case of pus pockets, and local infections, and in a majority of cases the light should be used in conjunction with internal chemical adjustment. Ultraviolet rays do not cause permanent injury to the eye, but do temporarily irritate the conjunctiva if given too strong exposure.

Mueller (Loss of Hair, published 1915, William R. Jenkins Co., New York) states that the Finsen light has not been of much use in the treatment of affections of the skin, but that the Kromayer lamp may be used successfully in treating certain scalp diseases such as ring-worm and circular baldness; still better results have been obtained with Nadelschmidt's modification of the quartz lamp (the Alpine Sun Lamp) with which he has treated over two hundred cases for loss of hair caused by various scalp diseases. It is stated that out of these cases treated, five and one-half per cent. were failures and eighty-four per cent. yielded satisfactory results. It is noted by Mueller that treatment with ultraviolet light conduces to a more rapid restoration of hair which has been lost due to illness or severe nervous strain. It is also noted that in treating hair with ultraviolet light the new growth of blonde hair is usually of a lighter shade than the original growth, while in cases of dark hair, the new growth is usually somewhat darker.

After a treatment of the scalp with ultraviolet light, a swelling is produced which disappears after a few days, but the redness which develops remains for about two weeks and leaves a distinct pigmentation. In order to secure successful results in the treatment of hair with ultraviolet light, it is considered necessary to expose the parts treated to the direct rays from the lamp and at a comparatively short distance. Rays which have been reflected and direct rays projected from too great a distance have little or no effect in producing a cure for scalp ailments.

It should be noted in connection with the treatment of hair by ultraviolet light that all celluloid articles such as combs or pins which may be in the path of the rays, should be removed, as by long exposure these may take fire.

Action of Ultraviolet Light on the Eye.

In addition to the effects noted above concerning the action of ultraviolet light on the eye, the following observations have been included:

Birch-Hirschfeld and *Stimmel* (Arch. Ophth. Festscher. Sattler 90, 198, 1915; Zentr. Biochem. Biophys. 18, 510-1, 1916) state that ultraviolet rays play a considerable role in the production of scotoma due to dazzling light; this form of scotoma is caused by the chemical transformation of substances associated with the perception of light and soon disappears. The production of cataract is also discussed in this connection.

Corlo (Ann. oculist, 142, 41; Zentr. Biochem. Biophys. 17, 648, 1915) has observed an incipient cataract formation in the posterior cortical layers of a perfectly healthy man who had been exposed during a period of three years to the action of mercury vapor light which was extremely rich in ultraviolet rays.

The mode of action of ultraviolet radiation in injuring *living cells*, with special reference to those constituting the *eye* have been investigated by *Burge*. (Am. J. Physiol. 39, 335-44 1916.) The effect of ultraviolet radiation on *paromecia* and *egg white* is to cause coagulation. The effective region of the spectrum lies between 254 and 302 uu. The eyes of frogs and fish living in tap water were not noticeably injured by five to twelve hours exposure to ultraviolet radiation, while in solutions containing calcium chloride or having sodium silicate in the cells of the eyelids and of the cornea the effectiveness of ultraviolet radiation in producing eye trouble is increased. Abnormal amounts of calcium salts on the skin also increase the effectiveness of the short wave lengths in sunlight in producing sunburn.

Spuler discusses some of the conflicting views entertained regarding the action of ultraviolet light on the retina and other media of the eye. (Carlsruhe Scientific Society, Scientific American, Sept. 13, 1913.) The subject is treated more particularly with reference to the problem of illumination.

Miscellaneous Effects.

Delbet and *Beauvy* (Compt. rend., 159, 278-91) have made a comparative study of the action of ultraviolet rays on the hemolytic power and colloidal state of blood serum. After subjecting blood serum to the action of ultraviolet rays for twenty-three hours no changes were noticed after ultramicroscopic examinations. The hemolytic power of the serum was reduced one-half after being subjected for seventy-five minutes to the rays.

Torraca (Int. Monatsschr. Anata., 30, 297-325; Zentr. Biochem. Biophys., 16, 892) states that the long continued action of ultraviolet rays causes degeneration of the cutaneous epithelia. A remarkable cap-like arrangement of the pigment around the nucleus was observed.

Henri and *Moycho* (Comptes. rend., 158, 1509-11) have measured the action of monochromatic ultraviolet rays on tissue; and the radiant energy corresponding to that which causes sunstroke.

Berthelot claims to have reproduced artificially the processes of digestion by the action of the ultraviolet rays from a mercury vapor lamp on food substances contained in a quartz vessel. The processes were produced without the aid of the ferments which play so great a part in the natural organism.

(To be continued in the July issue.)

THIRD NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES.

The Third National Exposition of Chemical Industries, to be held at the Grand Central Palace, New York, during the week of September 24th this year, preparations for which are in active progress, will this year be larger and more interesting than its predecessors. The advisory committee in charge is composed of Chas. H. Herty, chairman; Raymond F. Bacon, Leo H. Baekeland, Henry B. Faber, Colin G. Fink, Bernhard C. Hesse, A. D. Little, R. P. Perry, Wm. Cooper Proctor, E. F. Roeber, G. W. Thompson, T. B. Wagner, Utley Wedge and M. C. Whitaker. The managers are Charles F. Roth and F. W. Payne. At the close of the past exposition much of the space available on two floors then used was reengaged by exhibitors for this coming exposition. The present time sees these floors completely taken and the greater part of the available space on the third floor engaged.

Interesting Processes to Be Shown in "Movies."

The Bureau of Commercial Economics at Washington is again preparing many of the motion picture films that will be shown at the Exposition, and many exhibitors have now in preparation pictures showing phases in their work in the manufacture of their products. These will all be of absorbing interest, particularly as many are of processes that have been photographed for the first time, and their first showings will be made at the exposition.

The program of speakers has not yet been announced, but we are informed that it will be composed of many of the nation's leaders of thought, and men who have come prominently to the fore in the nation's hour of need.

The exposition is using this year a very attractive poster stamp which was obtained by a competition of the students of poster designing at Cooper Union, New York.

THE CHEMICAL ENGINEER

VOL. XXV. JUNE, 1917 No. 1

Published Monthly by the

McCready Publishing Company.

ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, JUNE, 1917

Coal-Tar Chemistry 121
Edited by Thomas H. Norton, Ph.D., Sc.D.

Under which is included:

I—EDITORIALS:

Foreword 121
The Merger of Leading Manufacturers of Coal-Tar Crudes, Intermediates and Colors....... 121
America's Chemical Progress................ 126
George H. Bruce, A.M., LL.B.
Coal-Tar Chemists to Advise Government..... 126

II—COAL-TAR CRUDES:

Standardization of Benzol Tests in Coke Works. 127
Receivers of Aetna Explosives Co. Secure Privilege to Fulfill Contract................ 127
Explosion in Barrett Co. Plant.............. 127

III—COAL-TAR INTERMEDIATES:

A Cyclic Process for the Manufacture of Phenols 128
Electrolytic Production of Coal-Tar Intermediates 128
Manufacture of Sulfonic Acids.............. 129

IV—ARTIFICIAL COLORS:

Manufacture of Coal-Tar Colors in England:

I—Position on the Outbreak of War........ 129
C. M. Whittaker, B.Sc.
II—Progress in British Dye Making.... ... 130
Anonymous.
Growth of the Coal-Tar Color Industry in Other Lands 133
A New Method for the Use of Chrome Mordant. 135
Coal-Tar Research at Huddersfield.......... 135
War-Time Utilization of German Patents..... 135
American Synthetic Indigo.................. 135
Valuable Dye Discoveries Reported.......... 135

V—NATURAL DYES:

Present Position of Natural Dyes in British Industries 136
Natural Indigo 137
Says U. S. Army Heads Discriminate Against Vegetable Dyes 138

VI—SYNTHETIC DRUGS AND PERFUMES. PHOTOGRAPHIC DEVELOPERS:

Synthetic Perfumes 138
Ernest J. Parry, B.Sc., F.I.C.
Synthetic Drugs Obtained from Coal-Tar..... 139
Picric Acid from Certain Gums.............. 141
Disinfectants Derived from Acridine Dyestuffs. 141
Interest Aroused in Suit Over "Aspirin" as a Trade-Mark 142
Effect of the War on the Production of Photographic Developers 142
T. Thorne Baker.
May Waive Patent Law to Protect Government from Extortion 143
Coal-Tar Dyes as Medicines................. 143
Cost of Salvarsan.......................... 143
French Duty on Saccharin................... 143

VII—MISCELLANEOUS:

Nationality and Chemical Research.......... 143
British Exports and Imports of Chemicals.... 143
Oakes Co. to Erect New Buildings.......... 143

VIII—BOOK REVIEWS:

"The Aniline Color, Dyestuff and Chemical Conditions" 144
"Annual Chemical Directory of the United States" 145
Profits of Swiss Color Manufacturers......... 145

IX—WHOLESALE PRICES OF COAL-TAR PRODUCTS:

Crudes, Intermediates and Explosives, Synthetic Medicinals, Flavors and Perfumes, Photographic Developers, Artificial Colors........ 146
Natural Dyestuffs, Dyewoods and Raw Materials, Extracts, Dyeing Accessories......... 147

DYE NOTES:

Cadmium Derivatives of Acridine Dyestuffs for Use as Bactericides...................... 147
British Profits in the Artificial Color Industry.. 147
Zobel, Stern & Campbell Incorporated......... 147
Ultra-Violet Light: Its Application in Chemical Arts. Part IV.......................... 148
Carleton Ellis and A. A. Wells.
Table of Contents.......................... 154
Chemical Investigation, Efficiency and Control.... 155
Conducted by Charles B. Davis.
Distillates: News Notes of Chemical and Allied Industries 156
Foreign Trade Opportunities................. 158
June Prices of Chemicals.................... 160

POSITION WANTED: College trained chemist wishes position in dye, food, drug, or similar concern; steady and reliable; do not ask higher wages than I can earn.
ROBT G. EVANS, M. A., Jamestown, Pa.

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.

ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

J. A. K. If you will forward me exact data as to the construction of your machine and also where I may see it in operation, I will be pleased to submit it to some practical tests and render my report. The fee in a case of this sort cannot be determined until the tests have been made.

G. A. M. One cord of hard maple, weighing 3,875 lbs. will yield in good practice, 11.8 gallons of 82% wood alcohol and 293 lbs. of 80% acetate of lime. The yields for birch are not so high, while the alcohol yield for ash, tanbark, oak and eucalyptus is practically equal to maple.

J. E. S. The Bureau of Standards has discovered the secret (formerly held by the Germans) of making chemical procelain commercially, thus making the United States entirely independent of foreign markets. Without this product, the industrial chemists, pushed as they are now by war needs, would be seriously handicapped.

N. R. T. The patent on Aspirin (acetyl salicylic acid) has expired. The trade mark (being registered in the U. S. Patent Office) is still the exclusive property of the manufacturer. This product, having the formula $(C_6H_4. O. COCH_3. COOH.)$ is colorless, crystalline and melts at 135° C. It is soluble in alcohol and ether but only slightly so in water.

G. S. D. The Meat Inspection Laboratories specify in their regulations just what may be added to meats for curing, etc. Substances which impair wholesomeness are prohibited; only harmless artificial coloring is allowed and its presence must be declared on the label. Diseased and abnormal tissues are submitted to the Pathological Division. The samples containing parasites are studied by the Zoological Division.

A. E. M.—Arachis and Rape Oil is now being used as adulterants for Olive oil and should be looked for in all shipments. Half pint samples will be required for the analysis. The fee for this type of examination is moderate.

G. G. A. The coloring is entirely dependent on added turmeric, no anilin coloring being detectable. Turmeric, being an artificial dye, will necessarily have to be recorded on the label, in order to comply with the pure food law.

R. B. C.—You are correct in your statement that J. Bodnar, of Budapest, isolated the enzym, Zymose, from stored potatoes and ripe sugar beets, but in place of alcohol being formed, the soil bacteria enter as spores into the enzym extract thus converting the alcohol into acetic acid.

R. B. C.—The acetic acid content of your cider vinegar should be at least 4% and a pint sample will be required for the analysis. The volatile reducing substance present in the distillate is acetylmethylcarbinol $(CH_3. CHOH. CO. CH_3)$ and is a normal constituent of all cider vinegar.

H. E. W. You either do not maintain the proper pasteurizing temperature for the required period or your containers are not air tight. I would suggest that you send me a sample of both the treated and untreated material so that I may submit them to a very careful biological investigation. The bitterness of your milk and cream is caused by bacterial growth of very rare occurrence. I would advise the most scrupulous cleaning of all parts of your plant.

Charles B. Davis.

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail are specifically requested, communications can only be considered in the order of their receipt.—Editor.

DISTILLATES

News Notes of Chemical and Allied Industries

Empire Gas Co.

The Empire Gas Co. has been incorporated with a capital of $500,000. A. J. Duncan, incorporator.

Paper and Paper Products.

Grass-Fiber Pulp & Paper Corporation, Dover, Del., has been incorporated with a capital of $150,000 to manufacture paper and paper products.

American Chemical Products Co.

American Chemical Products Co., Connellsville, Pa., has been incorporated with a capital of $6,000. The incorporators are N. J. Davidson, Connellsville; H. L. Mitchell, W. E. Moore, Pittsburgh.

Will Manufacture Kaolin.

Columbia Mineral Products Co., Columbia, S. C., has been incorporated with a capital of $20,000 to manufacture kaolin. The incorporators are F. L. Whittemore, F. W. Attwood, W. J. Keenan, Jr.

Good Chemical Co., Inc.

Good Chemical Co., Inc., Roanoke, Va., has been incorporated with a capital of $50,000 to conduct an oil business. The incorporators are L. M. Good, C. W. Robinson.

Central Glass Co.

Central Glass Co., Delaware, has been incorporated with a capital of $1,000,000 to manufacture glass of all kinds. The incorporators are C. M. Egner, L. Rimlinger.

Dyes, Chemicals, Colors and Drugs.

The Gold Leaf Natural Dye Co., Inc., New York, has been incorporated with a capital of $500,000 to deal in dyes, chemicals, colors and drugs. The incorporators are R. L. Warner, H. Campbell, 150 Nassau Street.

Chemicals, Dyestuffs, Colors, Etc.

Jaffrey Manufacturing Co., Trenton, N. J., has been incorporated with a capital of $50,000 to manufacture chemicals, dyestuffs, color, etc. The incorporators are B. D. Phillips, New York; H. H. Umberger, L. E. Conover, Trenton.

Lemaco Chemical Co.

The Lemaco Chemical Co., Hackensack, N. J., has been incorporated with a capital of $100,000 to manufacture chemicals, pharmaceutical chemicals and other preparations and articles. The incorporators are B. Barnet, Paterson; James H. McClellan, Boston, Mass.; I. Cohen, Ridgewood.

Will Manufacture Oxygen.

The Linde Air Products Co. will build a $100,000 factory to manufacture oxygen at Denver, Colorado.

Will Rebuild Fertilizer Plant.

The Arkansas Fertilizer Co., Little Rock, Arkansas, will rebuild, at a cost of about $25,000, its plant which was destroyed by fire some time ago.

Potash Company to Rebuild Plant.

The National Kelp Potash Company, Long Beach, Cal., will rebuild its plant which has been destroyed by fire.

Corcoran Chemical Co.

Corcoran Chemical Co., Durham, N. C., has been incorporated with a capital of $125,000 to carry on the business of chemists and druggists.

To Manufacture Chemicals.

L. J. Lewery & Co., Inc., New York City, has been incorporated with a capital of $25,000 to manufacture chemicals, etc. The incorporators are L. J. Lewery, W. Sutton, M. A. Kahl.

Colors, Chemicals, Etc.

Max Marx Color and Chemical Co., 192 Colt Street, Irvington, N. J., has been incorporated with a capital of $100,000 to manufacture chemicals, colors, etc.

Trinitrotoluol Now Duty Free.

The Giant Powder Company has been sustained by the Board of United States General Appraisers in its contention that T. N. T. should come into the country duty free.

New Silica Tube Mill Lining.

An adamant silica tube mill lining has recently been placed on the market by the Jasper Quarry Company, of Sioux City, Iowa. The new product has been successfully used in cyanide plants and cement mills and also in a silica plant.

Professor McCoy Resigns His Post.

Dr. H. N. McCoy, whose process of extracting radium from carnotite is being used by the Carnotite Production Co., of Chicago, and who is also interested in the production of thorium and related products, has resigned as professor in the chemistry department of the University of Chicago to devote his time to his technical interests. Dr. McCoy is a director in the Carnotite company and also in the Lindsay Light Company, also of Chicago.

Will Manufacture Acids.

Imperial Chemical Works, Warren, Pa., has been incorporated with a capital of $15,000 to manufacture acids. Clarence J. Hesen, incorporator.

By-Products from Waste Liquors.

The Wool-Wash Products Corporaton, Manhattan, has been incorporated with a capital stock of $5,000 by F. F. Pratt, E. Kemble and B. J. Crombie, 21 Park Row, New York City, to reclaim solids from waste wash liquors.

Dyes, Paints and Chemicals.

Durex Aniline Works, Inc., Manhattan, has been incorporated under the laws of New York to deal in dyes, paints and chemicals. The stock is $10,000, and the incorporators are S. E. Baer, H. M. and M. Toch, 329 West 86th Street, New York City.

Coal-Tar Products.

The Congoleum Company has been incorporated under the laws of Pennsylvania with a capital stock of $200,000, to deal in coal-tar products. The New York representative is H. E. Huelat, 230 Fifth Avenue. New York City.

Dixie Graphite Co.

Dixie Graphite Co., Delaware, has been incorporated with a capital of $150,000 to manufacture graphite, iron and steel. The incorporators are C. E. Brooks, Ashland, Ala.; W. L. Shumate, Jr., F. W. McMiller, J. F. Berry, Birmingham, Ala.

Chemicals, Drugs, Paints, Etc.

Eastern Aniline and Chemical Co., Inc., has been incorporated in Delaware with a capital of $2,500,000 to manufacture chemicals, drugs, paints, etc. The incorporators are C. L. Jordan, George F. Barght, G. G. Gates, Yonkers, N. Y.

Aniline Dyes.

24625.—A company in India wishes to be put in touch with American manufacturers and exporters of mill, gin, and railway stores, machinery, hardware, electric goods, aniline dyes, canvas and rubber goods, etc. Catalogues, quotations, etc., should be submitted. References.

Burrell to Direct Gas Warfare Investigation.

Research work on matters pertaining to gas warfare to be carried on by the U. S. Bureau of Mines, will be conducted under the direction of G. A. Burrell, consulting chemical engineer of Pittsburgh, Pa. Mr. Burrell has been in charge of the Bureau's gas investigations for the past eight years, and was appointed to this new task by Van H. Manning, director, who is chairman of a committee of the National Research Council, which is a branch of the Council of National Defence.

Chemicals.

Toronto Chemical Mfg. Company, New York, has been incorporated with a capital of $20,000 to manufacture chemicals. The incorporators are E. A. Eichner, J. M. Cuff, M. Mouilus, 220 West 42d street.

U. S. Gun Oil Co.

U. S. Gun Oil Company, Beaumont, Texas, has been incorporated with a capital of $20,000. The incorporators are E. T. Dickson, A. L. Dickinson, J. M. Johnson.

Southern Oxygen Co.

The Southern Oxygen Company, Austin, Texas, has been incorporated with a capital of $20,000. The incorporators are E. H. Perry, D. C. Reed, F. G. Smith, O. H. Miliken and J. B. Robertson.

To Make Wood Alcohol.

Pierce & Stevens, Inc., Buffalo, N. Y., have been incorporated with a capital of $10,000 to manufacture wood alcohol. E. B., G. E. and A. E. Stevens, Buffalo, are the incorporators.

Inks, Acids and Paper.

The U. S. Patent Ink Sales Corporation, Manhattan, has been incorporated under the laws of New York with a capital of $50,000 to deal in inks, acids and paper by S. Werner, J. Mann and C. E. Ackerman, 1562 Broadway.

Drugs; Chemicals; Dyestuffs.

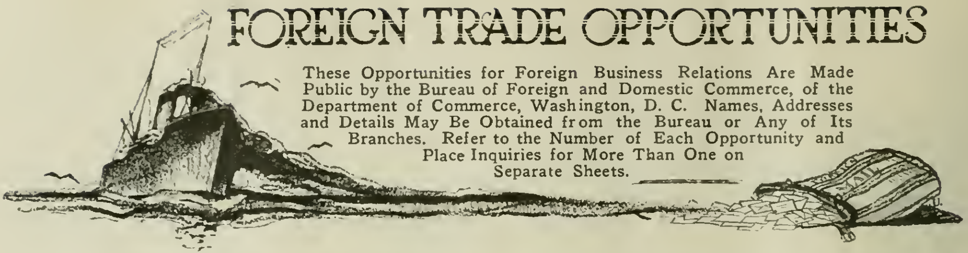
Jay White Manufacturing Co., Inc., Brooklyn, has been incorporated with a capital of $5,000 to manufacture drugs, chemicals and dyestuffs. M. Hillowitz, C. Jacobs and B. Rabinovitz, 396 Georgia Avenue, Brooklyn, are the incorporators.

Fifth Branch for Marden, Orth & Hastings.

Marden, Orth & Hastings Company, 61 Broadway, New York City, have opened a new branch in the Hoge building, Seattle, Washington, which makes the fifth American branch of this firm. The company handles heavy chemicals, coal-tar, intermediates, aniline dyes, dyewood extracts, tanning extracts, oils and greases.

Fertilizer Producers Meet.

Plans for the supply and distribution of fertilizers were discussed at a recent meeting in New York City of a sub-committee of the National Fertilizer Association, at which all of the producers present announced their willingness to place their plants at the disposal of the government. It was brought out at the meeting that steps were being taken to assure an adequate domestic supply of pyrites and sulphur, which were formerly imported in large quantities from abroad.



FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Ethers for Temperance Drinks.

24547.—A man in Argentina wishes to represent American manufacturers and exporters of ethers used in the manufacture of soft or nonalcoholic drinks.

Glucose, Sugar, Vanillin.

24540.—An agency is desired by a firm in Switzerland for the sale of glucose, sugar, vanillin, tin boxes, vegetal and animal hair, cloth for mattresses, linen thread, snap buttons, raw cotton, oils and greases.

Leather.

24612.—A firm in Italy desires to purchase leather and any other articles, especially in leather dresser. Quotations should be made c. i. f. destination. Payment will be made by bank credit. Correspondence may be in English. References.

Coke Ovens, Chemical Plants.

24623.—An agency or representation of American firms is desired by a man in England for the sale of mining plants, colliery, coke ovens, by-products plants, chemical plants, or any other high-class engineering products. References.

Cerium Ore.

24564.—A merchant in Spain is in the market for cerium ore. Quotations should be made c. i. f. destination. Payment will be made upon delivery of goods. Articles should be packed as compact as possible. Correspondence should be in French or Spanish. Reference.

Explosives, Chemicals, Laboratory Apparatus.

24646.—The director of economic affairs of a foreign government is in the market for laboratory apparatus, photographic accessories and apparatus, bicycles and accessories, combustibles, waterworks, drains, electrical apparatus and supplies, clothes and dress goods, explosives, office stationery surgical instruments, agricultural materials and supplies, building materials, printers' supplies, medicines, furniture, tools, chemicals, food supplies, etc. A more complete list of the goods desired, and full information in regard to terms, etc., may be obtained from the bureau or its district office.

Acetyl Blue and Black Chrome Leather.

24677.—A company in Italy is in the market for acetyl blue and black chrome leather, 88 pounds of which can be used daily, if satisfactory. Quotations should be made c. i. f. destination. Correspondence should be in French or Italian. References.

Dyes and Chemicals.

24659.—The manager of a company in Japan, who is at present in the United States, wishes to be placed in communication with American manufacturers and exporters of general merchandise and all kinds of dyes and chemicals. Quotations should be made f. o. b. factory. Correspondence may be in English. Reference.

Scientific Instruments and Supplies.

24668.—A firm in Roumania wishes to be placed in communication with American manufacturers and exporters of precision instruments for physical appliances, optical instruments, general supplies for railroads, especially rolling stock, general supplies for the petroleum industry and viticulture, construction materials, and equipment for hospitals.

Drugs and Chemicals.

24653.—A man in India desires to purchase chemicals, drugs, patent medicines, mill, gin, and railway stores, patent foods for babies and invalids, condensed milk, oil engines, electrical goods and accessories, and machinery. He also wishes to entertain an agency proposition. Quotations should be made c. i. f. destination. Payment will be made by drafts through banks or through confirmed letter of credit. Correspondence may be in English. References.

Dyestuffs; Coal-Tar for Heating; Etc.

24655.—A commission merchant in France wishes to represent American manufacturers and exporters of different products, especially rare minerals and ores, particularly wolfram; silicates; bauxite; graphite; high petroleum oils, coal tar for industrial heating purposes; chemical products, especially dyestuffs, railway rails; fish plates and bolts; iron wire; automobile parts, platforms for railway freight cars and parts for freight cars, especially metal parts to be assembled in France.

Ferrocerium.

24562.—A firm in France is in the market for ferrocerium for cigar lighting.

Drugs and Chemicals.

24479.—Catalogues and prices are desired by a doctor in Central America from American manufacturers and exporters of drugs and chemicals. Correspondence should be in Spanish. Reference.

Saltpeter, Naphthalin and Other Chemicals.

25651.—A firm in Italy desires to purchase saltpeter, naphthalin, carbonate of ammonia, logwood and logwood extract, patinson magnesia, carbonate of magnesium, and crystallized soda. Quotations should be made c. i. f. destination. Correspondence should be in French or Italian. Reference.

Heavy Chemicals.

24692.—A commission merchant in Spain wishes to purchase and secure an agency for the sale of heavy chemicals. Quotations should be made f. o. b. New York. Payment will be made by cash against documents at destination. Correspondence may be in English. References.

Cheap Writing Paper and Pads.

23985.—A firm in Peru desires to purchase cheap ruled and unruled writing paper in packages, cheap envelopes, and cheap writing pads. Quotations should be made f. o. b. New York or c. i. f. Callao, if possible. Correspondence should be in Spanish. Reference.

Iron, Tin, Etc.

23941.—A man in Spain wishes to purchase iron, tin, and other metals. He also desires to entertain an agency proposition. Quotations should be made c. i. f. destination, if possible; otherwise f. o. b. New York. Payment will be made against shipping documents. Correspondence may be in English. Reference.

Alum, Chrome Alum and Acids.

24472.—A company in India wishes to be put in touch with American manufacturers and exporters of hardwood, piece goods, hosiery, oils, paints, drugs, belting, files, pulleys, mill machinery and parts, patent medicines, food for invalids, steel and iron plates, steel hoops, galvanized iron, wire netting, window glass, wire nails, cotton undershirts, towels, iron bars and angles, antimony, red lead, alum, chrome alum, acids, electrical goods, brass and copper wire, rods, pipes, paper washers, bolts, nuts, screws, cotton cords and ropes, dyed yarns, sanitary articles, such as bathtubs, urinals, etc.; heavy chemicals, such as zinc chloride, magnesium chloride, farina, calcium chloride, aniline dyes, rosin, etc. References.

Chemicals, Etc.

24575.—A firm in Spain desires to secure an agency for the sale of steel, hardware, chemicals, and kindred products. Reference.

Aniline Dyes.

24551.—A man in Argentina is desirous of representing American manufacturers and exporters of aniline dyes. Correspondence should be in Spanish or French. References.

Industrial Chemicals.

24514.—An agency is desired by a man in Italy for the sale of all kinds of merchandise, especially industrial chemicals, hardware, cutlery, greases, vegetable oils, etc. References.

Cellulose and Wood Pulp.

24675.—An agency is desired by a business man in Italy for the sale of cellulose and wood pulp for the manufacture of paper. Quotations should be made c. i. f. Correspondence should be in French or Italian. Reference.

Carbolic Acid.

24689.—A man in Spain wishes to secure an agency for the sale of carbolic acid. Quotations should be made f. o. b. New York. Payment will be made by cash against shipping documents at destination. Correspondence may be in English. References.

Chemicals: Tannin.

24589.—Quotations are desired by a man in France on steel plates for boilers and ships, angles, hoops, steel sheets, rounds, nails, iron and steel implements, lard, bacon, salmon, lobster, dry vegetables, leather, rubber, boots and shoes, oil and oil cakes, chemicals, hemp, jute, flax, colors, and tannin.

Sodium Bicarbonate.

24012—A merchant in China wishes to purchase bicarbonate of soda in 10-ton lots. The soda should be put up in double sacking. Quotations should be made c. i. f. Chinkiang. Cash will be paid. Correspondence may be in English, but Chinese is preferred.

Chemical Products and Aniline.

24672.—An agency is desired by a merchant in Argentina for the sale of supplies for druggists, liquor dealers, grocers, and dyers; chemical products and aniline, such as ethers, caramel, acetic acid, effervescent, orangeflower water, rose water, tartaric and citric acid; machines for making carbonated waters, soda, for bottling, putting on stoppers and caps, siphons and bottles for soda, and all machines connected with the liquor trade; and bottle caps. Correspondence should be in Spanish.

JUNE PRICES OF CHEMICALS, ETC.

For Detailed Prices of Coal-Tar Direvatures See Page 146

CHEMICALS, ORGANIC.

Acetanilid, lb.	.45	@	.48
Acetic acid, 28 per cent	4.15	@	4.30
Acetic acid, glacial	.40	@	.50
Alcohol, 190 U. S. P.	3.46	@	3.48
Alcohol, denatured, bbls.	1.00	@	1.02
Alcohol, wood, 95 per cent	1.00	@	1.02
Alcohol, wood, 97 per cent	1.05	@	1.07
Amyl acetate	4.00	@	4.25
Benzoic acid, Ex Toluol	5.00	@	5.35
Carbolic acid, drums	.43	@	.45
Carbon tetrachloride	.16	@	.16½
Chloroform	.60	@	.62½
Citric acid crystals	.72	@	.75
Glycerine, C. P. drums	.61	@	...
Glycerine, cans	.62½	@	...
Glycerine, dynamite	.59	@	...
Pyrogallic acid, resublimed	3.15	@	3.25
Pyrogallic acid, crystals	2.90	@	3.10
Salicylic acid	.80	@	1.35
Tannic acid, technical	.75	@	.90
Tartaric acid, crystals	.78½	@	.83

CHEMICALS, INORGANIC.

Acetate of lime, gray, 100 lbs.	4.50	@	4.55
Alum ammonia, ground	.05	@	.05¼
Alumina sulph, iron free	.04	@	.04½
Ammonia aqua, 26 deg., lb.	.06¼	@	.06½
Barium chloride	85.00	@	90.00
Barium nitrate	.12	@	.13½
Blanc fixe, paste	.03	@	.03½
Blanc fixe, powder	.04	@	.04½
Blue vitriol, carlots	.09½	@	...
Blue vitriol, powdered	.12½	@	.13
Borax, crystals	.07¾	@	.08
Brimstone, ton	45.00	@	50.00
Caustic soda, 76 per cent	.06¾	@	...
Calcium sulphate	.10	@	.20
Glauber's salt, 100 lbs.	.65	@	.70
Nitric acid, 40 degree, 100 lbs.	7.36	@	7.50
Phosphoric acid, 50 per cent	.23½	@	.25½
Potassium bichromate	.36	@	.37
Potassium bicarbonate	1.20	@	1.25
Potassium chlorate, crystals	.50	@	.55
Potassium cyanide, mixture	.70	@	.75
Sodium acetate	.10	@	.13
Sodium bicarbonate	.02	@	.03½
Sodium benzoate	5.00	@	5.50
Sodium nitrite	.30	@	.40
Sodium phosphate	.05	@	.06
Sodium prussiate	.30	@	.35
Sodium chlorate	.25	@	.26
Sodium salicylate	.85	@	1.35
Sodium sulphide	.02	@	.02½
Sulphuric acid, 66 deg.	.75	@	2.00
Sulphur, flowers	2.95	@	3.10
Tin bichloride	.19¾	@	.20¼
Tin oxide	.64½	@	.66½
Zinc oxide	.16	@	.21

DYE MATERIALS.

Annatto, cans	.32	@	.33
Aniline, oil	.30	@	.32..
Aniline, salt	.34	@	.38
Albumen, blood	.55	@	...
Albumen, egg	1.05	@	...
Albumen, egg yolk	.42	@	...
Beta naphthol, sublimed	.85	@	...
Carmine, No. 40	4.25	@	4.50
Cochineal, silver, lb	.51	@	.52
Cochineal, black, lb	.60	@	.62
Gambier, lb	.16¼	@	.16½
Indigo, madras, lb	1.10	@	...
Logwood, extract, lb	.11	@	.15
Madder, Dutch, lb	.25	@	.26
Myrabolans	40.00	@	45.00
Paranitraniline	1.20	@	1.25
Soluble Blue, lb. powder	.75	@	.78
Sulphur, black, lb	.60	@	.90
Sulphur, brown, lb	.25	@	.50
Turmeric, Aleppo	.10	@	.10½
Turmeric, Madras	.08¾	@	.09
Zinc dust, lb	.22	@	.28

ESSENTIAL OILS.

Almond, bitter, lb	14.00	@	16.00
Amber, rectified	2.25	@	...
Anise	1.07½	@	1.10
Camphor	.16	@	.20
Cinnamon, lb	...	@	20.00
Clove, cans	1.95	@	2.00
Cubeb	5.25	@	5.50
Ginger	8.00	@	...
Limes, distilled	2.70	@	2.75
Pennyroyal, American	1.65	@	1.85
Peppermint, tin	2.35	@	2.70
Rose, natural, oz.	22.00	@	...
Wintergreen, synthetic, oz.	.75	@	...
Wormwood, oz.	3.25	@	...

OILS.

Codliver, Newfoundland, bbls.	75.00	@	85.00
Castor crystals, lb.	.25	@	...
Castor, "A.A."	.24	@	...
Castor, No. 3	.23¾	@	...
Corn, crude	14.81	@	...
Corn, refined	16.41	@	16.61
Cocoanut, Ceylon	...	@	.18
Fusel, Haarlem	6.00	@	...
Menhaden, light	.90	@	.92
Menhaden, brown	.86	@	.88
Menhaden, winter	.92	@	.94
Menhaden, extra	.94	@	.96
Myrbane, drums	.19½	@	.20
Myrbane, cans	.20	@	.21

THE CHEMICAL ENGINEER

COAL-TAR CHEMISTRY

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives.

Crudes, Intermediates.
Artificial and Natural Colors.
Synthetic Medicinals, Flavors, and Perfumes.
Explosive, Photographic Developers.

Edited by
Thomas H. Norton, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

Sidney Blumenthal, President, "The Shelton Looms," Shelton, Conn.

George H. Bruce, LL.B., Gold Leaf Manufacturing Co., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph. D., Aetna Explosives Company, New York.

John C. Hebden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles.

H. Gardner McKerrow, of the Marden, Orth and Hastings Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

EDITORIALS—Section I

After the War—What of the Export Trade in Chemicals?

Chronological reference throughout the world, for generations to come, will center around the Titanic tragedy across the waters, steadily drawing into its crimson maelstrom one nation after another.

Events and epochs will be located as, "Before the World War"; "During the War"; or "After the War."

The chemists of this land, since August, 1914, have been forced to face a multitude of complex problems. Prior to that date, the United States depended almost exclusively upon European sources for the greater number of its manufactured chemicals, drugs and dyes. Suddenly the sources were closed to us. Nearly every branch of industrial activity was affected. Even the agriculturist was deprived of the wonted rations of potash for his broad acres. This country realized, as never before, to what a degree its industrial life depended upon the products of the technical chemist.

What was done? Did our manufacturers close their factories and abandon the struggle? Far from it!

Ingenious makeshifts were adopted here and there, but the great burden of responsibility was placed upon American chemists. They were put upon their mettle, and right nobly they responded.

We have a small army of American chemists. Some are occupied with the production of a few staple chemicals upon a large scale. Most are occupied normally with the control of the use of chemicals in hundreds of different branches. Suddenly they were summoned to create the manufacture of the most diverse compounds, with the production of which they were totally unfamiliar.

Yankee pluck, and determination, and adaptation and inventive ability were quite as marked assets in their inventory, as were technical and scientific attainments.

And the result? One by one the different phases of chemical manufacture, hitherto unknown to us, or known only in a tentative, hesitating way, have been organized and placed upon a permanent foundation. There remains still much to do. But never before, in the annals of technology, have so many new products been introduced into the cycle of a nation's industrial activity, in so short a space of time.

---

*Address, delivered by the Editor of the "Chemical Engineer," on June 30, 1917, at the Export Conference, held under the auspices of the first Eastern States Agricultural and Industrial Exposition, at Springfield, Mass.

The output of the new branches has been steadily increased, until in not a few cases, it exceeds the domestic consumptive demand.

Most marked has been the creation of a coal-tar chemical industry destined shortly to render us entirely independent of foreign sources for hundreds of synthetic colors, medicinals, flavors, perfumes and photographic chemicals.

We are creating a national potash industry, limited to a few compounds in point of number, but destined, ere long, to emancipate us from dependence upon the mines of Stassfurt.

We are likewise building up a national nitrogen industry, bound to free us soon, from paying further tribute to Chile.

The few chemical industries which we possessed before the war, have been expanded to a notable degree. Three years ago they attempted little beyond supplying the domestic demand. Now their products are sent in constantly increasing quantities to every part of the globe.

In the fiscal year 1913-14 the value of these exports was twenty-seven million dollars ($27,000,000). In the current fiscal year, 1916-17, the value will exceed one hundred and eighty million dollars ($180,000,000).

Three years ago our imports of chemicals were valued at ninety-four million dollars ($94,000,000). This year the value is about one hundred and seven million dollars ($107,000,000). The quantity is materially less than in 1913-14.

And now, our manufacturing chemists, our economists and our statesmen, are seeking to draw aside the veil of the future They ask: "After the war—what of this marvellous export trade in chemicals, increased sevenfold in the course of three years? Can we hold it to any extent? Or, will our present customers, upon the return of normal international excnanges, revert to the old-time sources of supply?"

No precise, categorical reply can be given to these inquiries. The factors involved are too numerous, and some are vague and uncertain.

A careful analysis of our present export trade in chemicals reveals, however, conditions and tendencies, which lead strongly to the conclusion that a goodly share of this phenomenal movement of one class of our products may be permanently retained, if the proper foresight, energy and resoluteness are displayed, and that without loss of time.

Some of our chemicals, especially the acids, are demanded in enormous quantities, for shipment to Europe, and are used almost exclusively in the manufacture of munitions of war. France, Italy and Great Britain are the chief purchasers. We have no reason to expect that this phase of the trade movement will continue after the war. Far different may be the case with our increased exports to other regions. The possibilities become evident if we establish a comparison between the quantities, or values, of various articles exported to continental divisions during the fiscal years 1912 and 1916:

EXPORTS OF LEADING AMERICAN CHEMICAL PRODUCTS.

Continental Divisions. Articles.	Europe 1912	Europe 1916	North America 1912	North America 1916	South America 1912	South America 1916	Asia 1912	Asia 1916	Oceania 1912	Oceania 1916	Africa 1912	Africa 1916
Acids, sulphuric........lbs.	....	42.783,000	6,423,000	34,457,000	578,000	4,674,000	....	23,000	1.500	41,000	....	44,000
Acids, all other............$	66,000	19,709,000	269,000	1,155,000	19,000	452,000	300	1,279,000	9,000	105,000	20	17,000
Alcohol, wood..........gals.	1,475,000	1,283,000	37,000	86,000	100	30,000	50,000	41,000	3,000	30,000	....	70
Bark extracts, for tan....$	142,000	3,971,000	231,000	1,556,000	60	103,000	21,000	210,000	10,000	44,000	....	20,000
Calcium carbide.........lbs.	166,000	68,000	20,364,000	17,734,000	10,131,000	18,314,000	68,000	365,000	945,000	676,000	534,000	616,000
Copper sulphate........lbs.	2,773,000	13,744,000	825,000	1,476.000	2,804,000	2,757,000	....	....	....	1,250	....	....
Dyestuffs ....$	150,000	2,542,000	130,000	1,944,000	2,390	265,000	1,200	305,000	31,000	42,000	....	4,500
Petroleum jelly............$	359,000	723,000	39,000	86,000	40,000	124,000	52,000	68,000	32,000	76,000	14,000	21,000
Roots, herbs, barks.......$	456,000	531,000	74,000	71,000	900	63,000	13,000	58,000	5,000	36,600	700	10,000
*Soda and sodium com...$	....	5,534.000	....	2 981,000	....	1,981,000	....	1,581,000	....	492,000	....	80,000
Miscellaneous chemicals..$	1,584,000	32,417,000	5,242,000	11,966,000	1,040,000	4,456.000	530,000	5,890,000	709,000	1,238,000	215,000	255,000
Fertilizers,.......long tons	400	10,000	61,000	112,000	360	1,120	1,550	50	12	80	150	2.000
Paints, dry colors........$	450,000	669,000	213,000	531,000	46,000	183,000	36,000	93,000	33,000	87,000	9,000	28,000
Paints, white lead......lbs.	14,101,000	20,995,000	1,013,000	1,633,000	62,000	3,451,000	7,000	253 000	524.000	2,646,000	30,000	128,000
Paints, zinc oxide......lbs.	29,671 000	22,382,000	2,892 000	8,134,000	1,600	344,000	....	305,000	228,000	51,000	....	8,000
Soap, toilet......... ....$	496,000	855,000	439,000	694,000	473,000	470,000	60,000	136,000	333,000	373,000	38,000	83,000
Soap, common .... lbs.	25,977,000	23,010,000	24,500,000	44,880,000	3,592,000	3,374,000	266,000	783,000	2,324.000	3,200,000	193,000	301,000

*No detailed record was kept in 1912 of the exports of sodium compounds, as the quantities were insignificant. Even in 1915, the total value was less than one-quarter of the figure for 1916.

While figures for the fiscal year 1916-1917 are not yet available, it may be stated that the total exports of American chemicals are over twelve per cent. (12%) greater in value than was the case in 1915-16.

Unfortunately the statistical work of our Treasury Department is sadly restricted in regard to chemicals. Many would gladly know the details falling under the comprehensive designation above, of "miscellaneous chemicals," the total export value of which, for 1916, exceeded $56,000,000.

The survey of our shipments to continental divisions other than Europe, regions which have hitherto drawn their chemical supplies largely from Germany, and to a lesser extent from Great Britain, and a few adjacent countries, reveals at a glance how we have multiplied our economic relations with Latin America, Asia, Africa and Oceania. Numerous are the cases where the export has been trebled or quadrupled. Frequent are the instances where there is a tenfold increase. But when South America increases her purchases of white lead from sixty-two thousand (62,000) lbs. to three million four hundred and fifty-one thousand (3,451,000) lbs., or of dyestuffs from two thousand three hundred and ninety dollars ($2,390) to two hundred and sixty-five thousand dollars ($265,000), when Asia increases her import of miscellaneous chemicals from half a million dollars to nearly six million; or, when Oceania buys two million six hundred and forty-six thousand (2,646,000) lbs. of white lead from us, instead of five hundred and twenty-four thousand (524,000) lbs., we begin to realize the possibilities of our foreign trade in this field, which has hitherto been so neglected.

In 1906 the international trade in chemicals, drugs, dyes and fertilizers had a total value of five hundred and ninety-two million dollars ($592,000,000). At that time the purchases of non-European countries were:

Asia	$40,731,000.00
Africa	6,767,000 00
Oceania	2,322,000.00
Canada	10,933,000.00
Latin America	20,203,000.00
Total	$80,956,000.00

It is probable that the consumptive ability of these regions, under normal conditions, would be, today, nearly double the above figures, or about one hundred and fifty million dollars ($150,000,000).

Here is a territory in which American commercial enterprise is steadily gaining, in which we should intrench ourselves with a fixed determination to hold the situation.

If you ask just how this campaign is to be organized and how it is to be waged, I may not be able to outline with certainty every detailed feature. But I can tell you very easily, and with confident assurance, just how victory is *not* to be won.

It will most certainly not be gained if our American manufacturers of chemicals sit quietly and comfortably in their offices, patiently await the arrival of inquiries from the vast domain to the south of us, from Asia and Africa, and the islands of the sea, and placidly reply, in good Anglo-Saxon, to correspondence in a dozen different tongues, that their wares can be obtained in the quantities and containers customary to the domestic trade, against cash at time of shipment.

This is a time-honored procedure, but no branch of American export trade has ever achieved signal success by following the method.

A few weeks ago our nation was thrilled by the unexpected announcement that the commander-in-chief of the American expeditionary army had landed on the other side of the Atlantic, with his staff. And why the thrill? We each knew instantly and instinctively that a vast amount of preparatory work had been accomplished within a marvellously short period of time. We knew that, in its broader outlines a plan of operation had been decided upon, involving the co-operation and the co-ordinated effort of many thousands upon this side of the ocean. And finally, we knew that definite provision had been made for the exact performance of thousands of minor details, before General Pershing faced the billows of the Atlantic and their lurking, hidden dangers.

Our campaign to secure and maintain a market for American-made chemicals in two score countries, scattered over the face of the globe, must be undertaken in the same spirit.

We must know exactly what chemicals, and in what quantities, each of the foreign countries, coming into consideration, requires in normal times. It is necessary to ascertain the style and size of container to which the trade or the local consumer is accustomed, the general appearance of labels, the data required upon them, the varying degrees of purity or strength called for, legal requirements concerning the trade in chemicals and drugs, etc., etc.

Furthermore, we should know exactly the sources of the chemicals purchased before the war, the prices then paid, the system of credits and the whole mechanism of bringing the wares of foreign origin into the hands of the final consumer.

Concrete problems then assume shape. Given the current wholesale rate in Brazil, for, say, potassium permanganate in 1914, can an American producer furnish it at the same or a lower quotation? If not, what possibility is there of so shaping the costs of production in the American factory, so that a satisfactory rate can be established?

It may be assumed with tolerable certainty that by the time, when normal international exchanges are resumed, our banking and shipping facilities, in connection with nearly all foreign fields for commercial rivalry, outside of Europe and the Mediterranean litoral, will be such that we can meet competitors on practically even terms.

The chief problem in any specific case will concern the purity and availability of the raw material at the disposal of the American producer, and his ability to manufacture at a cost, not above that of his European competitor.

It has become an axiom in the evolution of American industries, that, given an equality of cost in primary materials, despite our high wage rates, we can eventually bring the costs of production to, at least, a parity with those in other countries, once a branch of manufacture is thoroughly rooted here, established on a generous scale, and completely standardized. The steel trade, the manufacture of locomotives, of machine tools, of typewriters, of agricultural implements, and scores of other instances may be cited in support of the thesis.

Such must inevitably be the outcome in our chemical industry. One after another, new features are being introduced. Each expands until it is able to cover the domestic demand. It is standardized and the costs of production are brought down to the lowest possible figure, in order to preclude competition at home. Now comes the question—to what extent can an output be found outside of our own territories?

This query cannot be answered exactly and intelligently, until the various categories of data, enumerated above, and applicable to the special product in question, have been ascertained.

Once in possession of the facts, however, the way is clear to plan for an aggressive campaign. The American producer faces, at this stage, the all-important problem—to what extent is he warranted by the consumption of his wares in any given country, in making the direct attempt to establish business connections?

In the great majority of cases he is sure to decide that the prospective gain is not sufficient to overbalance the outlay incident to securing a safe market for his specialties at most foreign distributing points. In the aggregate, the demand for his products may be large. The actual consumption in the individual countries will be, in most cases, too small to warrant separate, aggressive, energetic efforts to secure a firm foothold and meet eventual competition.

The problem is qute different from that encountered by the men who have built up our foreign trade in petroleum or cottonseed products, in locomotives, machine tools and the like. It is an attempt to displace the staple wares, supplied, until recently by the nation most powerful in its chemical industry and in the selling of its wares.

We can make the attempt, and with a fair chance of success. There is, however, but one general method of procedure which offers a confident assurance of achieving that success.

The simple Latin motto on our national coat of arms must be made the fundamental principle of our chemical industry, in a very literal and comprehensive manner, as far as its foreign relations are concerned, if permanent, durable results are to be assured.

The same unity of direction and control of details which characterize our expedition to the battlefields of France, must be duplicated in its broader aspects. The collective chemical industry must adopt the same policy and highly perfected mechanism, which has enabled our petroleum interests to establish permanent markets in practically every land.

What this prospective campaign demands is a carefully perfected organization, having for its sole object the building up of our chemical trade throughout the world.

It may result from the coming together, on a co-operative basis, of the chief representatives of the industry, or it may be established by far-sighted commercial or transportation interests, keenly alive to the possibilities of the immediate future.

Such a corporation would represent for the combined effort of all chemical branches in foreign territory the dominant, irrepressible tendency of the day, as we see it manifested in a single field, in the recent merger of the leading factors of the swiftly expanding coal-tar chemical industry of this country. To meet successfully the coming struggle of German rivals seeking to recover the lost dyestuff market, unity and solidarity are absolutely necessary. A solid front must be presented to the East.

In essentially the same spirit, a single corporate body could handle intelligently, effectively and comprehensively the foreign expansion of the entire chemical industry. It could collect the requisite data from each country. It could secure, on the most advantageous terms, the active co-operation, as agents, of the highly experienced and reliable wholesale firms in the chemical trade, in each leading center of distribution. It could gradually locate in such agencies, live, progressive American representatives, competent to infuse the national spirit and energy in the building up of the new relations.

The establishment of credits and banking connections could proceed hand in hand with the creation of chains of branches of American banking houses, soon to take place.

The organization of such a network of agencies, covering practically the globe, would involve no more labor or outlay for the entire industry, than it would for a single enterprising manufacturer, ambitious to create widespread foreign outlets for one or more of his specialized products.

The central corporation could not only secure notable economies by this system of collective representation, it could likewise reduce the item of transportation to the lowest possible figure, by its extensive annual contracts.

Its great function would be to make firm contracts for annual supplies in all distributing foreign centers, total the amounts, and make equally firm annual contracts with domestic producers to cover the needed quantities. The financing of such a corporation should be on such a scale that domestic producers would receive cash payment on the arrival of wares at the American port of shipment. Such a method of procedure would enable the American manufacturer of chemicals to quote figures for his annual shipments to foreign markets, with the lowest possible margin of profit. He would be entirely free from any uncertainty or risk, and could plan definitely for his monthly output, above the demands of the domestic consumption of his special wares.

In principle the mechanism of such a corporation would not be essentially different from that of our great steel corporation. In the latter the closest possible relation is established between iron mines, blast furnaces, steel and rolling mills, and the final consumers of the varied products, all through the medium of the single, central organization. The economies and advantages resultant from such combination and consolidation are evident to every business man.

It is only by the economies due to such a similar concentration in the merchandizing abroad of our chemicals and dyes and drugs that we can meet the rivalry of European competitors.

For a certain number of years we shall possess an artificial advantage. As a rule, business and sentiment have little to do with each other. But we all know that the passions and bitterness evoked by the great conflict now raging will affect commercial relations for years to come. Russia, France, Great Britain and her colonies and the remainder of their allies, or of those in close sympathy with their aims, will for a long time purchase by preference in the American market.

I have passed in rapid review the salient features of the situation and its wonderful possibilities. I am firmly convinced that we have it in our power to bring about a notable achievement in the expansion of our foreign trade, in establishing upon a permanent basis the demand throughout the world for the products of a comprehensive American chemical industry.

No other country possesses in equal wealth and variety the requisite raw materials. No country is better accustomed to finance and urge through to success projects of equal size and complexity. To no land is the major part of the world now looking with greater respect, admiration and confidence.

It remains for us to plan and carry into effect that combination, co-operation, consolidation and concentration of skilled and specialized effort, without which the attempt is useless. Above all, the golden opportunities of these fast-fleeting months should be utilized without delay! T. H. N.

The Necessity for an Early Standardization of Color Concentrations and Values

By H. Gardner McKerrow.

Something over a year ago it was a widely discussed question as to whether this country could make aniline dyestuffs which would fill the void left by the cessation of importations from Germany. Today this is no longer open to discussion. The work of twelve months has shown that colors in every way comparable with the best imported qualities can be, and are being, made in quantities which have already relieved the color using industries of this country from any fear of a ruinous shortage, or even of a partial dislocation of style requirements.

It is a matter of frequent remark that never were colors more brilliant than they are in the current styles, and when it is borne in mind that except for such left over stocks as were in the hands of certain dealers and mills, there has been practically no supply of imported colors available for nearly three years past, it becomes evident that the industry has passed the experimental stage and has reached a development of mature capability. With the exception of the comparatively limited supply from Switzerland, and the two lots which arrived by submarine—the extent and usefulness of which are even yet more or less mythical—there has been no importation of European dyes in that time, and it is fair to assume that American dyes are responsible for the vividness of the fashion shades now to be seen in the season's styles.

There is indeed, no reason why this should not be so; a chemical formula is a fixed factor, and given the possession of intermediates of a proper character and quality, the production of colors is a matter of chemical routine.

Now arrives the time, however, when American manufacturers must complete their intrenchments and protect their lines of communication, and so coordinate the various branches of their new industry that, when the world returns to sanity, they shall not be deprived piecemeal of the results of the magnificent effort which has been made.

No more important aspect of the question presents itself in this connection than that of "standardizing" the colors which are being manufactured by the forty or fifty establishments which have undertaken the development of the industry.

At present there are as many qualities of sulphur black or any other extensively used color as there are concerns making it. One firm makes what is termed a 5% color, while another makes a 7% or 8% quality.

But against what standard are these percentages estimated? Each chemist has his own standard, and when the matter is investigated it is generally disclosed that he has in his laboratory a standard which he has used for some years and which came originally from some supply which was available before the war, and which probably originated with some German dyestuff house at that time.

American Producers Must Have Own Standards.

American manufacturers, in order to hold the industry intact against future attack, must create their own standards, and there should be one table of such standards under which all can work, and against which all American made dyes can be offered. Every buyer of domestic dyes should be in a position to know that when he buys a color of a given strength or concentration it is sold to him under a guarantee that the strength or concentration is stated in terms of a well recognized standard, and that the value of it is in direct ratio with this standard.

No time should be lost in arranging for a conference of the leading makers of dyes at which this scale of standards would be fixed, and an adherence to such authoritative standards be secured for the protection of the industry.

Probably the best and fairest method of merchandising colors would be to offer them for sale at values per unit of coloring matter. On that basis all percentages and strengths, and all questions as to whether the colors were sold in paste or in powder form would be automatically adjusted.

Every manufacturer would be working on the same basis, and every purchaser of dyes would know at once the value of the color offered in relation to its price.

Standards Could Be Fixed by Permanent Board.

The ultimate outcome of such a conference would logically be in the establishment of a permanent board composed of recognized color chemists and manufacturers to which the whole trade would accord allegiance, and which would standardize the new colors as they were produced.

Such a board might very properly add to its functions the very important one of the arbitration of all disputes which might arise between manufacturers and purchasers on questions of strength and color value, eliminating litigation and saving the time which is now lost in such disputes, avoiding endless expense as well as the congestion of court dockets with which all industrial centers are now burdened.

A still further field of activity for such a permanent board would be logically available in connection with a phase of the industry which, while not of immediate urgency, is undoubtedly going to be one of the most important questions of the trade when the war is over—the arbitration of contract repudiations where this is based on questions of quality and the co-relation of deliveries with type samples.

In the early days of an impending shortage in supplies of dyestuffs, when the alarmist reports of the daily press induced scores of textile and paper mills to believe they were confronted with the necessity of shutting down their plants, contracts were eagerly entered into with the dyestuffs manufacturers who were in a position to offer goods, at prices and under conditions which were far more stringent than anything which had been experienced by American manufacturers prior to that time.

Prices at anywhere from five hundred to a thousand or more per cent. higher than normal were readily accepted, and stipulations as to delivery agreed upon which fully justified the description of the twelve months from October, 1915, to October, 1916, as a "seller's market."

Additional Work for Board.

So far, actuated partly without doubt by a patriotic desire to give support to the development of the new industry, but also by the absence of any degree of selection of strongly competitive conditions, mills have lived up to their contract undertakings with a fair measure of faithfulness. What the situation will be as the industry grows, and as competition in it increases, resulting in improved and reduced costs of manufacture and lower prices, and as the cost of intermediates becomes less, is another question.

Human nature would cease to express one of its most universal characteristics if, when that time arrives, there were not numerous attempts to repudiate the validity of what had come to be burdensome and unprofitable contracts. The most commonly employed method of accomplishing this would be to question the quality of the goods delivered, and to claim that these were not up to standard, and not equal to previous deliveries.

When that time arrives, what better assurance could those manufacturers who have invested millions of dollars in intermediate and dyestuff plants have that their interests could be protected, than the existence of a representative and expert board to which, by the mutual consent of the parties in interest, all questions of quality and standard could be referred with the knowledge that a decision would be rendered on an impartial finding as to facts, and with a minimum expenditure of time and money.

Such a board would necessarily have at its command a sufficiently equipped testing laboratory and a staff of experienced chemists, which laboratory could be made practically self-supporting out of the fees received from arbitrated cases, and from expert research work which it would be called upon to do.

Now is unquestionably the time to organize the machinery for some such development while the industry is still in its infancy, and while requirements are still such that a properly conceived mechanism of this nature could be established which would automatically adjust itself to future conditions, no matter to what proportions the industry may grow.

Eastern States Exposition

The first agricultural and industrial exposition of the New England States was held at Springfield, Mass., on June 23-30. The undertaking was admirably organized and brought together a stately number of exhibits of the leading industries of New England. They were handsomely housed in the spacious, permanent structures, erected in 1915, at Springfield, to serve for such purposes. Noteworthy, in this connection, were the instructive exhibits of the various bureaus of the Department of Commerce, which takes an increasingly active part in all such gatherings, tending to stimulate the expansion of the country's manufacturers and trade. The leading addresses on the opening day of the exposition were delivered by Governor Samuel F. McCall of Massachusetts, and by the Hon. Edwin F. Sweet, Assistant Secretary of Commerce, the latter choosing for his topic, "After the War—What?"

The most notable feature of the exposition was the series of export conferences, held daily. Under the management of Mr. Archibald J. Wolfe a large number of representatives of our exporting industries were gathered to discuss themes closely connected with the problems to be faced at the conclusion of the great war. The whole subject of the possibilities of mightily expanding our export trade and holding it in the face of intensive European competition was exhaustively studied from every point of view.

The leading address on "Textile Day" was by Mr. H. Gardner McKerrow, manager of the Textile Department of Marden, Orth & Hastings, New York, and an associate editor of the Chemical Engineer. It was devoted to "The New Dyestuff Industry." Some of the points of this address, elaborated in a more complete form, are to be found in the editorial columns of this issue.

The opening address on "Chemical Day" was by the editor of the *Chemical Engineer,* and is also reproduced in this number. It was devoted to the problems connected with the healthful expansion of the export trade in American chemicals.

He was followed by Mr. Louis K. Liggett, president of the United Drug Company of Boston, who discussed "Drug Exports After the War." Among other things he stated: "Since the outbreak of the war it is a question of either using the chemical industry of this country to supply our needs or ceasing to exist. For 25 years the chemical industry has been dependent upon coal-tar derivatives, and this will be true of the future. These coal derivatives we were importing and not producing. Today we have coal distilling and rectifying plants all over the country from which we are obtaining coal tar, benzol, toluol, etc., not only in sufficient quantities to supply our own needs, but actually adequate to take care of other parts of the world. Not less than $100,000,000 has been expended by us to bring about the development of this one product.

"Our exports following this war will depend upon two very important factors. The first factor will be the price of labor. If our labor prices are to be higher than those of European countries we are very apt to lose a large percentage of the export business that we have gained by reason of war conditions. As to whether our labor prices are to be higher is any man's guess. I have discussed this subject with many manufacturers who have had more experience than I with conditions in Europe. You can get as many different opinions as you will find different men on this subject. I personally am of the opinion that labor will have to be lower, following the war. I haven't the time to go into the reasons for it. I simply express it as my opinion, backed by the records of labor prices following all previous large wars.

"As to whether our labor prices will drop in comparison to the drop that will take place that will be determined only by the extent to which we will be involved in this war before it ends.

"The second factor in our ability to hold and increase our export business following the war is that of service. We have not learned yet that the foreign buying countries want their merchandise their way—not the American way; we have not learned that we must not ship our merchandise across the Equator in the same kind of containers that we ship across the Rockies; we have not learned yet that our customers' ideas should be ours, particularly when it is a foreign customer. Strange as it may seem, South American, and particularly the Latin speaking districts of Europe, do not consider price so much of a factor as they do service."

The closing address was by Mr. Albert H. Higbie of Madero Bros., New York, who spoke on "The Past, Present and Future of American Chemical Production and Export."

Mr. Higbie claimed that America, while not directly concerned in the struggle for democracy at the outbreak of the war in 1914, "lost its nerves" with the other neutrals. The sound financial structure of the country saved it from what might have been a disastrous panic. Enormous questions arose requiring immediate answers and attention—questions of vital importance to all branches of manufacture in this country. As a nation, we have a peculiar trait. We do not sit down in a laboratory and study for years, until we are forced to action. But when we are forced, we put our heart and soul into the work and are usually able to "put it over."

The Merger of Leading American Manufacturers of Coal-Tar Crudes, Intermediates and Colors

In the June issue of the Chemical Engineer, p. 122, a full account was given of the recent merger of the leading factors in the American coal-tar chemical industry leading to the incorporation of the "National Aniline and Chemical Co., Inc."

On June 21 the organization of the company was completed by the election of the following officers and directors: Wm. H. Nichols, chairman of the board; J. F. Schoellkopf, president; W. Beckers, first vice-president; I. F. Stone, second vice-president and treasurer; C. P. Hugo Schoellkopf, third vice-president; Wm. T. Miller, secretary.

The directors of the company are as follows: J. F. Schoellkopf, J. F. Shoellkopf, Jr., C. P. Hugo Schoellkopt, of the Schoellkopf Aniline and Chemical Works, Inc.; W. Beckers, Eugene Meyer, Jr., Chas. J. Thurnauer, of the W. Beckers Aniline and Chemical Works, Inc.; I. F. Stone, of the National Aniline and Chemical Company; Wm. H. Nichols, of the General Chemical Company; Henry Wigglesworth, J. M. Goetchius, of the General Chemical Company and Benzol Products Company; T. M. Rianhard, W. H. McIlravy, of the Barrett Company and Benzol Products Company; H. H. S. Handy, E. L. Pierce, of the Semet-Solvay Company and Benzol Products Company.

Financial Status.

The complete capitalization of the new company will include approximately 200,000 shares of 7 per cent. preferred stock of $100 par value, and 350,000 shares of common stock without par value. There are no bonds outstanding nor any other indebtedness except current liabilities. No public offering of the stocks of the company is contemplated, the total issue having been taken by the constituent companies in exchange for their properties.

The productive capacity of the company is now in excess of 30,000,000 pounds per annum, and it is rapidly expanding to meet the requirements of the domestic and foreign trade. The plants of the company are at Buffalo, Brooklyn, Wappingers Falls, N. Y., Easton, Penn., Marcus Hook, Penn., and Frankford, Penn.

"The aim of the management," states a leading official, "is to manufacture coal-tar dyes and intermediates which can compete successfully, both in quality and variety, with those heretofore imported. As the constituent units of the new company include manufacturers of raw materials, of intermediates and of coal-tar dyes, the company in one organization covers the industry from raw material to finished products."

The offices of the National Aniline and Chemical Company, Inc., will be at 244 Madison avenue after July 1.

COAL-TAR CRUDES—Section II

The Estimation of Toluene in Crude Petroleum

S. E. Bowrey (Chem. Tr. J., 1917, 60, 425) performs this as follows: The first operation is the elimination, by distillation, of all constituents boiling above 150° C., then washing. The distillate is then washed free from unsaturated hydrocarbons by sulfuric acid, alkali and water. A modification of Edelmann's SO_2 process for refining lamp oil is then applied. Results obtained by the author on ten successive extractions with liquid SO_2, at 35°, of an artificial mixture by volume of 15 per cent. aromatic and 85 per cent. paraffin hydrocarbons, are tabulated. The aromatics consisted of equal percentages of benzene, toluene and xylene (5 per cent. each) in admixture. Evaporation losses in air totaled 27.8 per cent., on an average, of which aromatics formed but 0.57 per cent. The use of a vacuum reduced this error. Tests to determine the relative solubilities of the three aromatics showed a tendency for benzene to dissolve in preference to xylene.

The combined extract (50-100 c.c.), still containing about 20 per cent. of paraffins, is fractionated very slowly with the best form of stillhead. A regular, slow distillation is much more important than the type of stillhead. To obtain accurate fractionation by one distillation, an apparatus was designed whereby the vapor passed through a narrow orifice in the stillhead, and the resulting slight increase in pressure in the distilling flask operated a mercury cut-off for the gas supply.

The sp. gr. of the fractions is determined by a Sprengel tube, as a rapid and accurate method for estimating small amounts of paraffins remaining. The sp. gr. at 15° of benzene is 0.884, of toluene 0.870, and of xylene 0.865. That of paraffins is deduced from similar fractions of pure paraffin spirit, separately determined. Figures are reduced to percentages of the original petroleum. An example of the method applied to 1,800 c.c. of crude oil is given in steps, and the results are tabulated.

In these days of high-priced toluene more and more attention is devoted to the possibilities of utilizing the small amounts present in certain petroleums.

The "Cracking" of Solvent Naphtha

The employment of the Rittman and similar processes to utilize petroleum residues for the production, by "cracking," of gasoline as well as of benzene and toluene, has notably enlarged the possibilities of ample supplies of these hydrocarbons during normal conditions. At the present time price quotations show that we are far from meeting current needs. The availability of the more complex and higher boiling constituents of coal tar as material for transformation into benzene, and especially into toluene, becomes, therefore, a matter of some importance.

Clive M. Alexander, of Port Arthur, Texas, has patented a method (Amer. Pat. 1,230,975, of June 26, 1917) which is claimed to effect such a transformation, with a fair yield, by the use of solvent naphtha. This solvent naphtha is an important fraction of the distillation products of coal tar. It boils between 140° and 170° C., and consists chiefly of the xylenes, pseudo-cumene and some of their higher homologues.

In the Alexander process it is driven, in the form of vapor, through heated tubes or retorts maintained at temperatures ranging from 600° to 1,000° C. A temperature in the neighborhood of 800° is found to be the most favorable. Under these conditions the naphtha yields a condensed distillate equivalent to 70 per cent. or more of the volume of the original liquid. The best results are obtained when the rate of passage through the cracking apparatus is such that at least 70 per cent of distillate is collected from the effluent gases and vapors. This distillate contains further a volume of liquid boiling within the same limits of temperature of the original naphtha, and which can be submitted again to the operation of cracking equal to about one-third of the original amount. A rate of speed in feeding the apparatus, allowing this recovery of practically one-third of the original liquid, seems also to be a favorable factor. About one-third of the condensate consists of a mixture of benzene and toluene, boiling between 75° and 130°. The remainder consists of naphthalene, diphenyl and other high boiling aromatic hydrocarbons.

The net result, under the most favorable conditions, is that one-quarter of the solvent naphtha is transformed into benzene and toluene, and one-third is recovered to be used over again.

The inventor finds that the same method is applicable for transforming high-boiling tar oils in creosote oil into low-boiling phenols.

Improvement in Tar Distillation.

The Sulzer Frères Soc. Anon., of Wintherthur, Switzerland, (Eng. Pat. 105, 198, of 1916), have devised a new apparatus for the distillation of coal-tar, intended to lessen the degree of carbonization from prolonged contact with the heated walls of a still. The operation of distillation is carried on in a horizontal drum, the entire external surface of which is exposed to the heating gases. A series of scoops, carried on a rotating shaft, continuously raise the tar from the bottom of the drum and deposit it on the upper walls. The arrangement is such that no portion of the tar remains long in contact with any given area of the inner surface of the still.

New Form of Naphthalene for Use as an Insecticide.

John B. Barrett, of Annapolis Royal, Nova Scotia, proposes (Amer. Pat. 1,230,648, of June 19, 1917) a new form of preparing naphthalene, for use as an insecticide. The hydrocarbon constitutes the chief part of a mixture, containing 90 per cent. of naphthalene, 80 per cent. of naphthols and 2 per cent. of phenol. The mixture is applied as a coating to inert substances—small balls, or the like—and an additional coating of a mineral oil is added, to prevent too rapid volatilization.

COAL-TAR INTERMEDIATES—Section III

Remarkable Explosion in an Aniline Plant

There occurred in the works of the Marden, Orth & Hastings Company, on April 21, 1917, a remarkable explosion in a stripper employed to recover the aniline dissolved in wash waters.

An explosion in connection with this operation has hitherto been unknown. As the cause of the recent accident seems, thus far, without explanation, a full description of the explosion is of importance to all engaged in the production of aniline.

We quote the following account furnished by Mr. Richard S. Bicknell, of the company in question, to "The Journal of Industrial and Engineering Chemistry" (Vol. 9, p. 720, 1917):

Description of Stripper.

"The stripper is a ⅜-in. steel tank 7 ft. in diameter and 8 ft. ⅜ in. deep, flat bottom and plate cover on top, all ⅜-in. steel. To stiffen the cover two 6-in. I-beams (12¼ lbs.) 16 in. between centers were riveted on the cover. The cover was bolted to the flange with about forty ¾ in.x1½ in. bolts. The bolt holes are spaced about 6 in. apart on three-quarters of the circumference and 12 in. on centers on the remaining quarter. The bottom has a 2½-in. outlet, with a plug cock which runs to the sewer. The top has a 2½-in. inlet with a cross. The cross has a 2-in. inlet with a valve and a 1½-in. inlet with a valve. On the top of the cross was a ¾-in. level safety valve and gauge.

"The stripper has a closed coil of 2-in. pipe for the purpose of heating, 8 turns, welded, connected in through the side with cast-iron elbows and nipples to the coil.

"There is a 1½-in. valve and line feeding the top of the coil with steam, and the bottom drains through a ¾-in. steam trap.

"On the cover was a manhole and a 6-in. vapor line outlet running up vertically for 6 ft. to 3 2½-in. coil in a 4 ft. x 6 ft. wooden tank. The vapor line, coil and coil-outlet have no valve. The coil discharges into a steel separator 5 ft. x 6 ft. The aniline is drawn off the separator.

Operation Just Prior to the Explosion.

"The stripper was filled with aniline waters up to just 30 in. from the top of the stripper by means of a steam siphon from the wooden tank in the yard, which is used as a reservoir for aniline waters. At 4:30 P. M., April 21, 1917, the cover was placed on the manhole of the stripper, and the steam turned on the coil between 4:45 and 5:15 P. M. by a workman. The stripper is operated by simply distilling the aniline waters, condensing the aniline and water in a coil and running same into a separator. About 5:45 P. M. the stripper exploded. A workman was 10 to 20 ft. from the stripper when it went up, and was splashed with water, undoubtedly from the stripper; the water was warm, not hot, and he was not burned.

Results of the Explosion.

"The cover of the stripper was blown off with considerable force, breaking all the bolts which held it on by tension. The cover was bent and the flange of the stripper bent. The cover landed on the edge of the floor beside the stripper

"The entire contents of the stripper (1,600 gallons) were thrown out, leaving a layer of 1½ in. of iron sludge in the bottom of the stripper. A hole 20 ft. x 25 ft. was torn through the roof, and an 8-ft. I-beam bent 18 in. out of line. The wire glass windows which were near were broken. The stripper was not damaged very much. The same cover was replaced, and except for a few fittings was satisfactory for service again.

"After the explosion the inlet valve to the coil was found wide open, 4¾ turns. The condenser was clear. The two valves on inlets to the cross on the cover were closed.

Comments.

"The aniline waters were analyzed with the following results:

Sample	Feed water as put into stripper Per cent	Liquid from bottom of stripper after explosion Per cent
Aniline	3.13	3.07
Acidity (as H_2SO_4).....	0.005	0.09
Nitro Compounds	None	None

"The explosion behaved as though a layer of explosive had been placed on the bottom of the stripper. It is almost inconceivable that the explosion could have been caused by steam because the 1½ in. steam inlet is the only supply. If this were led into the stripper through a break in the coil the contents of the stripper would probably have been heated to boiling before exploding. Even then it is difficult to see how the steam at 115 lbs. would create such a sudden and violent explosion, entering as it did, and with the exit condenser coil wide open."

New Method for the Preparation of Crude Sodium Salicylate

W. Everitt & Co., Ltd., and W. Everitt, of Southall, Middlesex, Eng. (Brit. Pat. 105,612, of 1916) describe a new process for preparing crude sodium salicylate from which salicylic acid itself can easily be manufactured.

The essential feature is the use of a rotary autoclave into which the charge of sodium phenate is introduced. Carbon dioxide is admitted at ordinary temperatures during constant rotation until absorption has ceased. The pressure of the gas is then raised to 100 lbs. per square inch, and maintained at this point for some hours. The gas inlet is then closed, and the autoclave is heated to 120°-140° C. until conversion is complete.

Autoclaves, for the purpose, are jacketed, and connection is made with both steam and cold water supply. A hollow trunnion permits the entrance of carbon dioxide.

The Evolution of Trinitro-Toluene

In "Drug and Chemical Markets" for June 6, 1917, Dr. Bernhard C. Hesse, who has done so much to familiarize the public with the marked dependence of our national preparedness against invasion upon the expansion of the country's coal-tar chemical industry, gives a striking illustration of this connection, in a short account of trinitro-toluene, or trinitrotoluol as it is more generally termed. Incidentally, the powerful economic rôle of isomerism among the intermediates of the aromatic series is strikingly illustrated.

"With the fall of Liége in 1914, the world at large became acquainted with a new and powerful military explosive, and its cabalistic symbol, T. N. T., acquired a horrifying and world-wide significance almost over night.

"Although then new to the world at large, T. N. T. was in reality known as early as 1863, but as a mere laboratory product. Its explosive properties were not recognized nor utilized until about 1880, but no particular attention was given to it as an explosive until about 1891, when factory methods for making it and suggestions for its wider use in the explosives field, military and otherwise, were published in Germany. It is described for explosive purposes in English text-books as early as 1896; Spain and France, prior to 1909, had introduced it into their military services and German manufacturers had long before that been engaged in introducing it into the military services of other countries.

"This material, T. N. T., is neither difficult nor dangerous to make. It is transported with greater safety than almost any other high explosive. When compressed under 30,000 to 40,000 pounds per square inch, it can be worked and cut into suitable forms. Loose, it is a white solid, half again as heavy as water, melts well below the boiling point of water and can then be filled into shells without danger from fumes or corrosion of the metal. It is slightly less powerful than picric acid. While the latter frequently pulverizes a shell, T. N. T. generally bursts the shell into fragments large enough to have a destructive effect. Like picric acid, it is explosive by means of a fulminate and does not, if pure or in proper form, explode of itself.

"On treating toluol—a water-white liquid (a 'chemical cousin' of benzol)—with nitric acid, three general classes of compounds are obtained: Trinitrotoluol, (T. N. T.), dinitrotoluol and mononitrotoluol. The last two are used in making dyes. Trinitrotoluol is made by treating dinitrotoluol or mononitrotoluol with more nitric acid. Of the mononitrotoluol the dye maker uses two different kinds, designated as ortho and para-mononitrotoluol, respectively. In making the ortho variety it is always accompanied by more or less of the para variety, and the reverse is also true At about the end of the nineties the situation was that more para was necessarily made than the world's dye market could consume, and more ortho could be used for dyes, if it could be had without making more para, or if a new outlet for para could be found. At that time the German dye makers were burdened with not less than 15,000 long tons of para, for which they were unable to find any use. This para costs about $180 per long ton to make, and this surplus meant about $2,700,000 of idle money. Worse than that, this was irresistibly growing at an alarming rate. Until about 1904 the German dye makers were most energetically, almost frantically, endeavoring to find new outlets for this para in the dye business, but without any real success. Then their feverish activity stopped short, ominously so. Liége, in 1914, gave the answer! These 15,000 tons of para, and all surplus that was since made, found their way into T. N. T. More than that, since 1904 or thereabouts the Germans have actually developed methods that gave much more para for a given weight of ortho than the older processes; they wanted this extra para for explosives.

"That Germans have employed T. N. T. as an explosive rather than picric acid is a logical outcome of industrial conditions in their land. Germany has never been so well placed as France, Belgium or Great Britain for large supplies of carbolic acid from which picric acid is generally made. As regards toluol, she has for years been better placed than these other countries. With this excess burden of para-nitrotoluol on her dye makers' hands, Germany seems to have taken the line of least resistance and made the most of her situation. Clearly, the German dye makers were actually driven into the explosives field; and seemingly they did not enter it as a result of any long-headed foresight on their part or on the part of their government. It took them thirty-seven years to get into the explosives field after the material for T. N. T. was accessible to them and to their government.

"In any event, the world has been taught a striking, if horrifying, object lesson, to what extent a domestic coal-tar dye business can aid national defense, even if through a flukish combination of circumstances. This is certainly good ground for the thought that, by intelligently and systematically exploiting the dye field further, an important national aid in the line of explosives, medicinal remedies, disinfectants and the like can be developed."

Recovery of Picric Acid From Wash-Water.

Henry A. Gardner, of Washington, D. C., patents an improvement upon the current methods of recovering picric acid from wash-water (Amer. Pat. 1,231,000, of June 26, 1917). Sodium bisulfate is added to the wash-water in sufficient amount to form a high-gravity solution. The picric acid present separates out in a flocculent form, forming a supernatant layer, which can be easily removed.

Separation of Aromatic Sulfonic Acids from Sulfuric Acid and their Technical Preparation in a Solid Form

It is not the industrial practice to separate the sulfonic acids of aromatic hydrocarbons, especially when destined for use in preparing hydroxy derivatives.

The usual commercial method of producing b-naphthol, for example, in the course of which naphthalene-b-sulfonic acid is formed but not isolated, has been as follows: Naphthalene is heated with an excess of concentrated sulfuric acid to 160° C. for a sufficient length of time to convert the naphthalene into naphthalene-b-sulfonic acid, in the presence of an excess of sulfuric acid. Lime is added to this mixture of sulfuric acid and naphthalene-b-sulfonic acid, forming calcium sulfate and calcium naphthalene-b-sulfonate. The difficultly soluble calcium sulfate is separated in solid form from the solution of the calcium sulfonate by filtration. This method of the separation of the two salts is, however, not sharp. To avoid appreciable loss of the calcium naphthalene-b-sulfonate, it is usually necessary to repeatedly wash the calcium sulfate with water in order to remove the sulfonate adhering thereto. Sodium carbonate is added to the solution of the calcium naphthalene-b-sulfonate, whereupon that compound is converted into sodium naphthalene-b-sulfonate and calcium carbonate is precipitated. The sodium sulfonate is readily soluble in water, while calcium carbonate is insoluble. Separation of the two salts may therefore be effected by treatment with water and filtration. The dilute solution of sodium naphthalene-b-sulfonate is then evaporated to dryness and the resultant solid is fused with sodium hydroxide, which converts the salt into sodium b-naphtholate. B-naphthol is liberated by treatment with a suitable acid, such as sulfuric acid.

It will be observed that the excess of sulfuric acid, which has not reacted with the naphthalene, is converted into the comparatively valueless calcium sulfate and thus lost.

Professor Louis M. Dennis, of Cornell University, has perfected a method (Amer. Pat. 1,228,414, of June 5, 1917), which materially simplifies the whole procedure in the manufacture of this class of compounds. It is as follows:

The mixture of naphthalene b-sulfonic acid and sulfuric acid, formed as above stated, is treated with a solvent such as toluene, which has the property of dissolving the sulfonic acid, but not of dissolving any appreciable amount of sulfuric acid. Toluene also possesses the property of dissolving an appreciably greater amount of naphthalene-b-sulfonic acid at 100° C., than it does at a low temperature, such as 5° C. The hot solution of the sulfonic acid in toluene, which separates from the residual sulfuric acid in a distinct layer, is removed and cooled, whereupon the naphthalene-b-sulfonic acid separates out from its solvent in solid form, and is freed from the toluene by filtration. Cooling to 5° C. gives good results. The solid naphthalene-b-sulfonic acid is then freed from any small amount of the solvent which may still adhere to it, either by evaporation, or by subjecting it to the action of a centrifugal. It may then be sold as such or further treated to produce naphthol.

To convert it into naphthol, its sodium salt may be prepared by adding to the acid, obtained as above, the calculated amount of sodium hydroxide, or sodium carbonate, and then fusing with the calculated amount of sodium hydroxide to form sodium b-naphtholate. This latter may be treated with an acid, such as sulfuric acid, in the usual way, to form b-naphthol. If the sodium sulfonate is in solution, the water must, of course, be removed before the fusion.

An alternative method is to add the acid directly, in dry form, to the solid sodium compound, the latter being in an amount sufficient to convert the sulfonic acid to sodium b-naphtholate, when the mixture is heated to the proper temperature. In this latter case sodium naphthalene-b-sulfonate is not formed separately. B-naphthol may then be formed from the sodium b-naphtholate, thus obtained, in the usual way.

The solvent, toluene, after being freed from the sulfonic acid, may be used again in the extraction of further portions of the acid from fresh mixtures. The sulfuric acid which remains after the sulfonic acid has been removed from it by the solvent, is drawn off and used for any desired purpose.

It is obvious that solvents other than toluene may be used to dissolve the sulfonic acid, provided they have the property of dissolving said acid, but of not dissolving any appreciable amount of sulfuric acid, and of dissolving appreciably greater amounts of sulfonic acid at high temperatures than at low temperatures. It is also of advautge if the solvent is not miscible with water to any appreciable degree.

It is further obvious that the invention has general application to the sulfonic acids of the hydrocarbons of the aromatic series.

B-Naphthol Derivatives for Disinfection Purposes.

The use of chlorinated and brominated derivatives of b-naphthol in the preparation of disinfecting solutions is described by H. Bechold, of Frankfurt a. M., Germany, assignor to the Chemische Fabrik Ladenburg (Amer. Pat. 1,232,187, of July 3, 1917). Compounds containing three or four halogen atoms in the molecule yield the best results. They are dissolved in an alcoholic solution of potash soap, and this is diluted with water, yielding a milky solution, prior to application for disinfecting purposes.

Diseases Incident to the Manufacture of High Explosives

The abnormal demand for high explosives, developed in this country during the past three years, led to the hasty construction of numerous works, and an equally hasty organization of the mechanism for producing vast amounts of nitro-derivatives of the aromatic hydrocarbons. Prior to the war explosive manufacture in the United States had been largely limited to what is known as peace explosives, and the "occupational diseases" incurred in plants of this kind were of relative unimportance.

There is but little danger to the workers from fumes in the processes that take place in the manufacture of black gunpowder and nitroglycerine. What danger there was had been studied carefully by physicians during the many years of the operation of the industry in this country and precautionary measures devised. But the necessity of haste in turning out great quantities of picric acid and trinitrotoluene as well as the nitric acid, and other substances used in the manufacture of high explosives, caused the hurried erection of plants poorly designed for the work, and the neglect of many precautions for the safety of operatives that had been in use in the plants in other countries where such manufactures had been carried on for many years. So many workers were incapacitated, permanently disabled and killed by industrial poisoning, while engaged in the manufacture of explosives, that an investigation of these plants was instituted by the United States Department of Labor and resulted in some surprising discoveries.

A study was made of forty-one plants, employing 90,000 workers, approximately 30,000 of these workers being women. In one of these plants it was found that to maintain a working force of 200 it had been necessary to employ a total of 4,000 workers during a period of thirteen months. Many of the buildings used had been constructed with poor provision for ventilation, so that the employees were frequently driven into the open by the fumes arising from the chemicals, and cases of lung poisoning and skin diseases were frequent. In the production of trinitrotoluene, a substance almost unknown in this country prior to the war, toxic jaundice had became prevalent among the workers, some of the cases developing fatalities. It was found that in twenty-eight plants, in the space of about one year, there were 2,507 cases of industrial poisoning, of which seventy-five were women. Of the total number of cases fifty-three were fatal, two of these being women. About 55 per cent. of the total cases and 53 per cent. of the fatal cases were caused by nitrogen oxides and nitric acid, while 28 per cent. of all cases and 25 per cent. of the fatal cases were due to trinitrotoluene, or TNT, which is manufactured and made into charges for high explosive shells.

An extremely dangerous process is the filling of shells with trinitrotoluene, either by pressing, which is very dust productive, or by molding, which involves fumes.

The reason nitrogen oxide poisoning or "fume sickness" heads the list is that all of these explosives are produced through processes of nitration in which a mixed acid is used, one of the ingredients being sulfuric acid and the other nitric acid. The higher the nitration the greater the danger from fumes. The 1,300 to 1,400 men who suffered from these fumes were employed in making nitrotoluenes, nitrobenzenes, nitro-naphthalenes, nitroglycerine and the nitric acid used for these processes.

The alcohol and ether, used in the manufacture of smokeless powder, threw off fumes which often resulted in making the men drunk, what is known as an "ether jag" being a common occurrence among the men engaged in the handling of these liquids. Before physicians had taken up the study of this phase of the business several men had been taken to the hospital and had their trouble diagnosed as intoxication, owing to the odor of alcohol on their breaths. One man, suffering from an over-inhalation of ether fumes, died shortly after being taken to a hospital, and the physician in charge gave the cause of his death as acute alcoholism.

Although the number of women employed in the various plants is large, 30,000, care has been taken in the majority of cases to have their field of labor confined to such processes as are not especially dangerous. As a result, the number of cases of industrial poisoning among female workers has been small in proportion to the number of men who have been attacked by gases.

Many manufacturers fell into the error that was so prevalent in English plants, in the early period of the war—that of working the men twelve or fourteen hours in the effort to stimulate production. Fatigue sensibly diminishes the powers of resistance to disease, and many workers in these plants were incapacitated through occupational diseases.

Physicians who have made a study of the effects of poisoning resulting from the manufacture of explosives state that the use of proper precautions will obviate much of this industrial poisoning. They advocate the use of masks and respirators by men engaged in the production of nitro compounds, such as trinitrotoluene and nitrobenzene, which throw off dangerous fumes, and the adoption of forced and rapid ventilation in all plants used for the manufacture of explosives. In addition, the best of sanitary facilities should be provided for the use of employes, and care be taken that none of the men become so fatigued by overwork as to lessen their powers of resistance to poison.

Valuable studies in this connection are found in the "Symposium on Occupational Diseases in Chemical Trades," published in the Journal of Industrial and Engineering Chemistry, 1916, *8*, 1054, and in the article on "Munition Plant Poisons," by A. Rice, in the American Journal of Public Health, 1917, *7*, 273.

C. W. Hancock, in the Canadian Chemical Journal, 1917, *1*, 33, also furnishes a helpful study on the same topic. In his opinion the ordinary hazards to industrial health are: (1) defective illumination, (2) poor ventilation, (3) long hours, (4) factory sanitation. The specific hazards of the chemical industry are: (1) superficial poisons, irritant and corrosive, such as alkalies and mineral acids; (2) blood poisons, such as CO and nitrobenzene; (3) poisons with definite internal action, which are again classified by their physical characteristics as poisonous dusts, fumes or liquids. The specific effects of a number of fumes, gases and other poisons are given, especially the action of aniline, which causes more industrial poisoning than any other organic compound, and methods of prevention and cure, are given in detail.

Analytical Studies

Among recent analytical studies on coal-tar compounds the following are of special interest:

"Aniline Method for the Estimation of Mineral Fillers in Rubber," O. H. Klein, J. H. Link and F. Gottsch, J. Ind. Eng. Ch., 1917, **9**, 140.

"Estimation of Phenol in Tar Oil Phenols," R. Masse and H. Leroux, Bull. Soc. Chim., 1917, **21**, 2; Analyst, 1917, **42**, 212.

"Action of Aromatic Amines on Fatty Acids," E. de Conno, Gazz. Chin. Ital., 1917, **47**, 93; Analyst, 1917, **42**, 213.

"Identification of Acids, II. Organic Acids," J. A. Lyman and E. E. Reid, J. A. C. S., 1917, **39**, 701.

"Analysis of Sulfonated Oils," W. K. Alsop, Report of 1917 Committee, J. Leather Chem. Assn., 1917, **12**, 266.

"Preparation of Diphenylamine Sulfuric Acid Reagent for Nitrates," W. Tonius, Z. Nahr. Genuss., 1916, **31**, 322; Analyst, 1916, **41**, 314.

"Modification of Price's Method for Separation of the Seven Permitted Coal-Tar Dyes to Include Tartrazine," C. Estes, J. Ind. Eng. Ch., 1916, **8**, 1123.

Theoretical Studies

During recent months the following results of research on coal tar derivatives, which possess more or less interest for the technical chemist, have appeared in various publications:

"Catalytic Action of Dyes on Formation of Colloidal Gold," I. Traube and N. Takayasu, Intern. Z. phys. chem. Biol., 1916, **2**, 453; J. Chem. S., 1916, **110**, 479.

"The Bucherer Reaction," H. Franzen and H. Kempf, Ber. 1917, **50**, 101; Abs. J. Chem. Soc., 1917, **111**, 262. After testing a number of acids it is concluded that the hydrolysis of aromatic amines is governed by the degree of non-saturation of the acid rather than by its strength.

"The Bisulfite Compounds of Azo Coloring Matters," N. N. Voroshcov, Ann. Chem., 1916, **6**, 381 and 293; Abs. J. C. S., 1917, **111**, 300.

"Relation Between the Chemical Constitution and Color of Azo Compounds," A. C. Sircar, Chem. Soc. Trans., 1916, **109**, 757; J. S. C. I., 1916, **35**, 960.

"The Heat of Combustion of Toluene," T. W. Richards and H. S. Davis, J. A. C. S., 1917, **39**, 341; Analyst, 1917, **42**, 220.

"Para-Quinoid Constitution of Pyronine," J. v. Braun and E. Aust, Ber., 1916, **49**, 989; Abs. J. S. C. I., 1916, **35**, 732.

"Investigations on the Production of Phenol by Microbes," A. Berthelot, Compt. rendus, 1917, **164**, 197; Off. Int. d'Hyg. pub., 1917, **9**, 530.

"Optical Activity of Low Temperature—and Generator—Coal-Tars," F. Fischer and W. Gluud, Ber. 1917, **50**, 111; Abs. J. S., 1917, **111**, 258.

"Preparation of O-Chloro-Toluene" (Ger. Pat. 294,638) (Bad), J. S. C. I., 1917, **36**, 286; Abs. J. C. S., 1917, **111**, 258.

"A New Benzanthrone Synthesis," A. Schaarschmidt, Ber. 1917, **50**, 294; Abs. J. C. S., 1917, **111**, 274.

"Spectrochemistry of Benzene Derivatives," Cinnamic Esters, etc., K. v. Auwers, Ann., 1917, **413**, 253; Abs. J. C. S., 1917, **111**, 266.

Toxicity of Benzene Derivatives to Insects.

W. Moore, J. Agr. Research, U. S. Dept. Agr., 1917, 9, No. 11,371, has made an exhaustive study of the toxicity of various benzene derivatives to insects. The vapor of 28 benzene derivatives was tested in this connection. The list included the CN, Cl, Br, I, OH, NH_2, CHO, NO_2, and CH_3 compounds of phenyl, the $(CH_3)_2$, Cl_2, Br_2, OHCl, $OHNO_2$ and OH CHO, the ortho and para $Br.CH_3$, ortho, meta and para $CH_3.OH$ and ortho $NO_2.CH_3$, benzyl alcohol—CH_2OH, benzoyl chloride COCl, $(CH_3)_3Br$ and $(CH_3)_3NO_2$ compounds. CS_2 was used for comparison with benzene compounds and furfural for comparison with aldehydic compounds.

The method consisted in exposing 5 house flies, in a corked liter flask at 70° F., for 400 min., or until dead. Results were calculated to millionths of a gram molecule, and reported in tables, and graphically by curves and blockings. The work is summarized as follows: (1) All compounds are more toxic than CS_2. (2) The physical character, boiling point, and vapor pressure, have more influence than chemical composition. (3) Up to 250° C., the higher the boiling point the greater the toxicity. Beyond 250° C. there is insufficient volatilization. (4) Lipoids are soluble compounds of low boiling point, and less soluble in those of high boiling point. (5) Compounds of low boiling point, though less toxic, may give better results because of volatility, especially in the fumigation of grain.

The experiments were undertaken in the hope of finding an insecticide, toxic to insects, while nontoxic to animals or plants. In a previous paper (J. Econ. Ent., 1917, 9, 71), the author pointed out the possibility of fumigating animals with nitrobenzene to destroy external parasites. Literature is cited at the end of the article.

Determination of Carbolic and Salicylic Acids in Antiseptic Gauze and Cotton.

J. B. Krak (Chem. Analyst. 1916, 17, 14) gives the following directions for determining the amounts of carbolic acid and salicylic acid in tissues for antiseptic use: Into a casserole weigh about 5 g.material, add 55 c.c. N NaOH, cover and heat on steam bath for 15 min. Filter, while hot, on a tared filter, and dilute filtrate and washings to 500 c.c. Wash the residue on filter with dil.HCl, alcohol and ether, dry at 100° and weigh. Into a glass-stoppered bottle pipette 100 c.c. Br solution, add 25 c.c. HCl, after 5 min. add an aliquot (100 c.c.) of the extract, after 5 min. add 4 g.KI, and after another 5 min. titrate 1 with N/10 thiosulfate. Tribromo products are formed. The bromide reagent is made by dissolving 2.5 g.$NaBrO_3$ and 25 g.NaBr in a liter of water, and is standardized by placing 25 c.c aliquots in a glass-stoppered bottle, adding 10 c.c. HCl (1:12) after 5 min. adding 3 g.KI and 5 min. later titrating with N/10 thiosulfate.

The Manufacture of Dimethyl-aniline, Monomethyl-aniline, Diphenylamine and Their Homologs.

In the Oil and Color Trade Journal, 1917, 51, 1892, two old autoclave processes for the manufacture of dimethyl-aniline are discussed. Full details are given for the Bardy process using aniline, methyl alcohol and sulfuric acid, and for the Brigonnet method using methyl chloride and slaked lime. The former method, with less methyl alcohol, is used for the production of methyl-aniline. The Girard and de Laire process for the manufacture of diphenylamine from aniline and aniline salt, and also a method similar to that of Bardy, for making diphenylamine, are outlined. Plans, sections, diagrams and descriptions of apparatus accompany the article.

Nitro-Carbazole.

The Actien-Gesellschaft für Anilin-Fabrikation, of Berlin (Ger. Pat. 295,817, of Nov. 6, 1912) describes a method for preparing 3-nitro-carbazole and its halogen derivatives by treating carbazole, or its halogen substitution products, with about two molecules of nitric acid, of 10 per cent. concentration.

ARTIFICIAL COLORS—Section IV

The Examination of Food Coloring Substances

W. E. Mathewson (J. Off. Agr. Ch., 1916, 2, 164) contributes a valuable study on this subject. It includes a brief discussion on pigments, soluble coloring matters and oil-soluble dyes. Methods for the separation of the eight permitted coal-tar dyes by the use of immiscible solvents follow. Outlines of methods of separation for basic and acid dye groups are briefly considered. The reactions of some of the commoner dyes with hydrochloric and sulfuric acids, sodium hydroxide and ammonia are tabulated as in Allen's Commercial Organic Analysis, Vol. V. A few special tests for the permitted colors, also very similar to the reactions given in Allen, page 647, are followed by methods of separation and identification of natural coloring matters. The tests and reagents are the same or modifications of those appearing in the literature. The results of a few tests on thirteen natural colors are tabulated, and the paper concludes with some modifications of old established tests of four common natural colors and a useful bibliography.

In Bulletin No. 448, of the U. S. Department of Agriculture, 1917, the same author contributes a fuller paper on "The Separation and Identification of Food-Coloring Substances," which includes in addition to the matter mentioned above a detailed method of separation for the colors commonly occuring in foodstuffs when the permitted colors are not used, an abridged procedure for the permitted dyes, and an extended table for the separation of food colors, giving the extraction value of three immiscible solvents, amyl alcohol from salt solution, from acid solutions of varying strengths, amyl alcohol-gasoline mixture from acid solution, ether from neutral acid and alkaline aqueous solutions, and dichlorhydrin from salt solution.

Tabulated results of reactions of dyed fiber with four reagents, two acid and two alkaline, follow, and also a table showing results obtained on the solution by a reducing agent followed by an oxidizing agent. Schmidt's oxidation test with bromine is discussed fully and table of results given, also the reactions of the dyes with nitrous acid and coupling with a-naphthol and their behavior when warmed with KCN. Brief reference is made to natural colors, repeating the reactions to a large extent found in the preceding paper.

New Azo Insoluble Dye.

The "Badische" Company (Ger. Pat. 295,025) describes a new dyestuff obtained by coupling aceto-acetic ester with diazotized 1-amido-anthraquinone.

Artificial Dyestuffs as Antiseptics

The vastly increased demand for effective antiseptics, in connection with war surgery, has notably stimulated the study of the availability of various coal-tar dyes for the purpose in view. British surgeons unite in regarding the acridine dye, trypaflavine, patented in 1910 by Cassella and Co., as by far the most useful antiseptic now at their service.

A solution of 1 :1,000 in water is sufficiently powerful. This is 1/400 the strength harmful to the body, and is equivalent to 80 per cent. phenol. Other antiseptics, strong enough to attack disease germs, have a bad effect on the tissues and lower the power of the blood corpuscles to repel infection. Flavine actually increases the efficiency of the phagocytes. In the presence of serum it is the most potent bactericide for stapholococcus, B. coli, enterococcus, anaerobes, etc. Its germicidal power is twenty times greater than that of $HgCl_2$, and 800 more than that of phenol. Licenses will be issued in England (probably without royalty) to Blandy Bros. and Levin stein for the manufacture of the product.

New Dyestuffs from 2.5.7-Amino-Naphthol-Sulfonic Acid

The Chemische Fabrik Griesheim-Elektron in a recent patent (Ger. Pat. 295,767, of Feb. 5, 1914), describes a new series of acyl derivatives of 2.5.7-amino-naphthol-sulfonic acid, obtained by condensing it with 2.3-hydroxy-naphthoic acid halides, or with their o-acetyl compounds. The products have a strong affinity for both animal and vegetable fibers. The leading derivative, 2.3-hydroxy-naphthoyl-2-amino-5-naphthol-7-sulfonic acid, yields in alkaline solution the characteristic yellow tint of the aryl-amino alkali salts of 2.3-hydroxy naphthoic acid. Cotton absorbs it readily from alkaline solution, and silk from acetic acid solutions. It combines easily with two molecules of diazo compounds, and a variety of colors, all fast to washing, are obtained by exposing to the action of diazo compounds fabrics which have absorbed the sulfonic acid.

Artificial Dyes in Forensic Analysis and Microscopic Technique.

E. Fuld (Bioch. Leitsch., 1917, *70*, 241), furnishes details on the utilization of Rhodamine and of Malachite Green in the detection of blood. A variety of new stains for microscopic work, derived from Methylene Blue, are described by L. Tribondeau and J. Dubreuil Compt. rendus, 1917, *164*, 551).

Proposes Modifications in the Tariff on Artificial Colors

During the hearings before the Senate Committee on Finance, in connection with the legislation for War Revenue, Mr. A. H. Weed, counsel for the Manufacturing Chemists' Association, presented a forcibly worded brief, calling for the elimination from section 501 of the tariff act of September 8, 1916, the parenthetical exception therein contained, by which the specific duty of 5 cents per pound is made inoperative in the case of "natural and synthetic alizarin and dyes obtained from alizarin, anthracene, carbazole and natural and synthetic indigo and all indigoids whether or not obtained from indigo." This class of colors, excepted from the operation of the act, constitute 27 per cent, in value, of all the dyes sent out from Germany to the United States in 1913, and the German exports then represented more than 80 per cent of the American consumption of all synthetic colors. To emphasize the importance of this criticism, Mr. Weed shows that of the 101 newly invented dyes since 1906, 74 per cent come within this exception. Of the tonnage of these new dyes, imported in 1913-14, 90 per cent come under this exception. These dyes are all adapted to displace the older aniline colors, and come into direct competition with them. It has been claimed that all sulfur dyes, which are the largest group developed thus far by domestic manufacturers, would evade the special tax and fall under the exception.

These statements were placed before the Finance Committee in calling attention to the need to amend the act of September 8, 1916. He points out the provision that the special duty shall cease unless an American industry shall have been built up in five years' time from September, 1916, capable of furnishing 60 per cent in value of the country's consumption. He shows that the percentage of colors excepted will have also added to it 90 per cent of the business developed in the new dyes.

"Thus," says Mr. Weed, "the American manufacturer in his race to attan 60 per cent. of the American consumption, in order to obtain the surtax provided for in the act, will be competing against the foreign producer who can defeat this object by obtaining considerably less than 40 per cent. of the business."

To accomplish the purposes set forth above Mr. Weed proposed an amendment to the act of September 8, 1916, to which he hopes to have the committee give favorable consideration.

The Use of Coal-Tar Dyes on Leather

Several recent papers give much information of value in regards to the use of artificial dyes on leather. They are here briefly abstracted:

"Skins for Fancy Leather Purposes" (The Leather Manufacturer, 1917, 28, 117) Various methods for the treatment of fancy leather for specific purposes are discussed at length. Processes for white leather and coloring quebracho tans, using titanium potassium oxalate, phosphines, and other coal-tar colors are given. Methods for dyeing skins black, blue or purple with acid blacks, or blue and purple with basic dyes, and of producing black grain and white flesh by sumac and acid treatment, followed by brushing with a basic black, are outlined.

"Drenching, Pickling and Tanning Skins for Fancy Leather" (The Leather Manufacturer, 1917, 28, 118). The preparation of leather for fancy coloring effects is described, and the dyeing of the same with marbled, spray and changeant effects. The tannage method admits of dyeing many beautiful shades and making stains suitable for special purposes.

"Bleaching and Coloring of Dark Vegetable-Tanned Leather" (The Leather Manufacturer, 1917, 28, 126). A treatment for removing excess color and preparing leather for the dyeing process is described in detail, followed by the actual dyeing or coloring process. Titanium potassium oxalate as a softener and whitener, and basic aniline dyes set with bichromate of potash are used.

Dyestuffs for Leather

The American Leather Chemists Association has a committee on dyestuffs, consisting of Messrs. Kressman, Wisdom, Orthman, Klober and Creese, which is actively engaged upon studies for establishing the comparative values of coal-tar colors for use on leather. Their report, submitted at the Fourteenth Annual Meeting of the association, appears in its "Journal," 1917, 12, 279.

As a preliminary trial of strength and quality of color, 1:50,000 solutions in water were compared with standards. The depth and hue produced by dipping filter paper in solutions were also compared.

Dyeings were then made on wool and cotton yarn and on leather by methods previously worked out by the committee. Methods are given for applying acid, basic, mordant and direct dyestuffs on cotton and wool yarn, and for acid, basic, direct and chrome dyestuffs on leather. Methods for calculating results are illustrated also, and necessary directions follow for the preparation of the leather and the other materials used in dyeing tests. The results obtained by the authors are tabulated and conclusions drawn as follows: (1) The leather test is unreliable as a means of valuation. (2) A mechanical tumbler is required to insure constant circulation and temperature. (3) Adjacent pieces of leather, of the same surface and weight, should be used. (4) Yarn dyeing shows not less than 5 per cent. differences. (5) For fine distinctions, to determine money value, the only reliable test is on textiles. (6) Some method of dye testing on leather should be worked out in preference to the test on textiles.

Papers on Dyeing

Color chemists will find valuable reading in the following papers:—

The Pyrone Colors, A. E. Everest, J. Soc. Dyers, 1917, *33*, 78.

Capillary Phenomena and Their Importance in Technical Processes, S. A. Shorter, J. Soc. Dyers, 1917, *33*, 78.

Chemistry of the Sulfide Dyestuffs, F. M. Rowe, J. Soc. Dyers, 1917, *33*, 9.

On the Distribution in Dyeing of Direct Colors Between Fiber and Solute, Knecht and Hibbert, J. Soc. Dyers, 1917, *33*, 9.

Dyeing and Cleaning, D. B. Lake, J. Phys. Chem., 1916, *20*, 701.

Better Use of Tanning Materials, Adaptation of Materials, Leather Mfr., 1917, *28*, 119.

The Application of Resorcin in Dyeing and Printing with the Basic Colors, A. Wossnessensky, J. Soc. Dyers, 1916, *32*, 278.

Black Dyeing on Tussah Silk, R. N. Sen, J. Soc. Dyers, 1916, *32*, 243.

Production of Aniline Black on Wool, R. N. Sen, J. Soc. Dyers, 1916, *32*, 244.

Dyeing Wool With Sulfide Colors, R. N. Sen, J. Soc. Dyers, 1916, *32*, 245.

The Artificial Coloring of Woods by Means of Dyes, Forestry Bur., U. S. Dept. Agr.

Methylene Blue as a Reagent in Chemical Analysis, A. Monnier (Arch. Sci. phys. nat., 1916, *42*, 210; Analyst, 1917, *42*, 51), describes a method in which Methylene Blue is applied successfully to the detection and estimation of perchlorates in Chile saltpeter.

A Rapid Method for Comparing the Decolorizing Efficiency of Charcoals, L. Wickenden and J. W. Hassler (J. Ind. Eng. Ch., 1916, *8*, 518), describe a method based upon the use of solutions of Sudan III or Oil Red RX in kerosene. Filtration is rapid and the filtrates are clear and bright. The preparation of a standard scale for classifying charcoals, and a simple colorimeter which aids the process, are described.

New Black Sulphur Dyes.

H. R. Vidal, of Asnières, France (Eng. Pat. 105,162, of 1916), prepares a new series of sulfur dyes from the p-amino derivatives of phenol, o-cresol or m-cresol. Any of the above may be heated with about half of its weight of either resorcinol or m-phenylene-diamine in the presence of sulfur. The apparatus employed is provided with a reflux condenser, so that condensed vapors continually flow back into the molten mass.

Vidal's Black, the pioneer of the various sulfur blacks, discovered in 1893, was obtained by the simple fusion of an amino-phenol with sodium polysulfides.

New Lakes in the Dihydro-anthraquinone Series.

Various lake colors are obtained by Meister Lucius and Brüning (Ger. Pat. 294,830) by precipitating the leuco compounds of n-dihydro-1.2.2^1.1^1-anthraquinone-azines through acetification of the vat solutions and subsequent oxidation.

NATURAL DYES—Section V

A New Dyeing Machine

Henry Higgs, of Amsterdam, N. Y., in a recent patent (Amer. Pat. 1,229,612, of June 12, 1917), assigned to the Klauder-Weldon Dyeing Machine Co. of Amsterdam, describes a new machine for use in both washing and dyeing.

The device is of a somewhat complex nature. Essentially it consists of a rotary member, composed of several compartments adapted to contain textile materials. These compartments are formed by longitudinal concavo-convex walls (the concavity of one wall facing the convexity of an adjacent wall), transverse end walls and peripheral walls. The machine is placed in a vat, provided with the requisite gear and transmission to cause rotation, and is continuously submerged during rotation.

The walls of the machine consist largely of perforated plate or of wire gauze. The peculiar construction, better understood by a study of detailed drawings, is such as to give to materials placed in the various compartments a rolling or epicyclic movement. It is claimed that this favors the penetration of the textile fabrics by dye liquor at every angle. The uniformity of the work and the rapidity of the operation are very distinctly heightened.

Dyestuffs from Yacca Gum and Congo Resin.

G. H. Frank, of Leeds, Eng. (Eng. Pats. 105,118 and 105,119, of 1916), obtains azo and sulfur colors from the Yacca gum (derived from *Xanthorrhoea arborea* and *X. hastilis*), and from Congo resin derived from *Hymenaea verrucosa* and *Copaifera copallina*). Yacca gum reacts with diazo or tetrazo compounds, for example, with diazotized sulfanilic acid in alkaline solution, and yields products which dye silk and wool yellow shades. They are susceptible of after-treatment with mordants. Such azo compounds, or the nitro and nitroso derivatives of yacca gum or of Congo gum, are readily transformed into sulfur colors by fusion with alkaline sulfides or polysulfides.

SYNTHETIC DRUGS AND PERFUMES PHOTOGRAPHIC DEVELOPERS—Section VI

Death of Alois Von Isakovics

The death, on June 5, at his residence in Monticello, N. Y., after a comparative short illness, of Alois Von Isakovics, removes from the ranks of American chemists a genuine leader in the field of synthetic perfumes and flavors.

Born at Prag, Bohemia, on July 20, 1870, the son of a distinguished officer in the Austrian army, he came to the United States in 1886. Not long afterward he devoted himself to the preparation of organic perfumes and allied compounds, especially those of synthetic origin. He built up an extensive business in this field, and gained a reputaion for the purity of his compounds which led to extensive relations with other countries. Von Isakovics combined in a rare degree high scientific attainments and remarkable technical and administrative ability. At the time of his death he was unquestionably the leading authority in this country on the subject of synthetic perfumes. His studies on the subject are to be found largely in the pages of the attractive "Synfleur Herald," issued from the Synfleur Scientific Laboratories at Monticello.

He lectured on the subject regularly in the chemical courses of Columbia University, and contributed a valuable chapter on "Essential Oils, Synthetic Perfumes and Flavoring Materials" to the "Industrial Chemistry," recently issued by Rogers and Aubert.

In 1895 he married Marie Upshur, descended from a prominent Southern family. His wife was closely associated with him in the evolution of his model perfume works at Monticello, and will direct them in the future.

Salvarsan

There is much interest shown in the recent establishment of a factory in Brooklyn for the regular manufacture, under the Ehrlich patent, of salvarsan, by the H. A. Metz Laboratories, Inc. It is claimed that the company will be able to sell the domestic product at one-half of the prices which have prevailed for the German article. The latter has been sold regularly at the rate of $6 for each ampule of 1.5 grams. Every effort has been made to restrict its sale to the medical trade and hospitals. Despite all precautions a certain quantity has come into the hands of speculators who demand double the normal price. The H. A. Metz Co. expects to place its product upon the market during the latter half of July. The works are under the direction of Dr. G. P. Metz, who has made an exhaustive study of every phase of the manufacture at the factory in Hoechst, Germany, which has hitherto met the world's demand. He has a staff of four chemists, and will employ about 100 operatives.

Sodium Phenetidino-methane-sulfonate.

P. Lepetit, in the Atti R. Accad. Lincei, 1917, [v] 26, i, 126 and 172, gives an extended study of the action of alkalies and acids upon sodium p-phenetidino-methane-sulfonate, known better under the name of nevralteine patented in 1908). Alkalies split off formaldehyde and sodium bisulfite, causing a condensation of two molecules to the imide. Other aryl amino-methane-sulfonates undergo the same transformation. The reaction offers a good general method for preparing imides. Boiling with dilute hydrochloric acid brings about the formation of a base, C_{18} H_{20} O_2 N_2, crystalline, melting at 140° C., and possessing marked anesthetic properties.

Limited Use of Saccharin Now Permissible in France.

For 15 years the use of saccharin in France has been prohibited by law. A recent decree allows the use of the artificial sweetening agent and similar products in the preparation of the following articles: Sparkling wines, liqueur wines, except wines intended for the manufacture of medicinal wines; cider and perry; liqueurs, except liqueurs for the export trade; lemonade, and coffee and tea for drinking.

An internal revenue tax of $17.50 per pound is imposed upon saccharin at the place of manufacture.

Current Production of Synthetic Perfumes.

The manufacture of artificial perfumes is seriously hampered at present by the increasing difficulty in securing some of the more important ingredients . It is almost impossible now to obtain pure pheny-ethyl alcohol, so indispensable for the preparation of artificial otto of roses. Another primary material, benzaldehyde, is likewise exceedingly difficult to find in a pure form, free from chlorine. The commercial grades, containing appreciable amounts of chlorine, which are readily employed in the dyestuff industry, appear to be fairly abundant.

Analysis of Synthetic Drugs.

The attention of those interested in the analysis of artificial medicinals is directed to the following recent paper on:

Salvarsan and Neosalvarsan, M. J. Webster, Analyst, 1916, *41*, 231; Ann. Chim. anal., 1917, *22*, 37.

BOOK REVIEWS—Section VII

"Notes on Military Explosives"

By Erasmus M. Weaver, Brigadier General, U. S. Army; Chief of Coast Artillery. Fourth edition, enlarged and revised. 436 pages. Illustrations from drawings. Price, $3.25 net. New York, John Wiley & Sons, Inc. London, Chapman & Hall, Ltd.

Exhaustion of the third edition of this exceedingly comprehensive work has given the author an opportunity to bring it up to date and to include such changes bearing upon the manufacture, use, storage and transportation of military explosives as have been developed during the last four years. It has particularly given him the opportunity to treat of the changes which have developed since the outbreak of the European war, the more important of which have been the substitution of wood pulp for cotton in the manufacture of the nitrocellulose explosives and the fixation of the nitrogen of the air by three separate processes. The initial chapter on fundamental principles of chemistry is useful for reference. The chapter on substances used in the manufacture of explosives is particularly exhaustive, and discusses the roles played by the various constituents as well as their sources. Each class of explosives receives full attention, and there are also copious remarks on storage, handling, service tests, etc. Matter in the appendix includes the revised regulations of the Interstate Commerce Commission in regard to the transportation of explosives.

"How To Build Up Furnace Efficiency"

By Joseph W. Hays. Tenth edition, 158 pages. With numerous illustrations from photographs and diagrams. Price, $1.00. Chicago, Joseph W. Hays. Christiania, Samuel Eie. Dover, Dover Printing & Publishing Co., Ltd.

This chatty, non-technical little volume deals exhaustively with the subject of needless coal waste in power plants. The author, a well-known combustion engineer, again advances the claim that one-quarter of the coal purchased by the average power plant is wasted through causes which are preventable. In the present edition he endeavors to show just how and why fuel is wasted, and follows his analysis up with two chapters devoted to methods of locating and stopping wastes. A final chapter includes a great deal of sound advice on keeping the wastes stopped. With this edition the book reaches its fiftieth thousand, and a perusal of it clearly indicates the reason for its popularity. It is designed to interest readers with no technical training and it succeeds admirably in its purpose, while its simple, straight-from-the-shoulder style drives home the lessons which it teaches without a conscious mental effort on the part of the reader

CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS—Section VIII

JULY 14, 1917

CRUDES.

Anthracene, 80 p.c.	lb.	.10	.12
Benzol, pure, water white	gal.	.55	.60
Benzol, 90 p.c.	gal.	.57	.59
Cresol, U. S. P.	lb.	.25	..
o-Cresol	lb.	.30	.35
Cresylic acid, 95-97 p.c.	gal.	1.10	1.15
Cumene (pseudo)	lb.	..	..
Dip oil, 20 p.c.	gal.	.29	.30
Naphthalene	lb.	.09¼	.10
Flake	lb.	.09½	.10
Balls	lb.	.10½	.11
Phenol (carbolic acid), U. S. P., cryst., drs.	lb.	.40	.42
Bottles	lb.	.42	.46
Pitch, various grades	ton	8.00	20.00
Pyridine	oz.	—	.25
Solvent naphtha, water white.	gal.	.19	.21
Solvent naphtha, crude, heavy	gal.	.13	.16
Toluol, pure, water white	gal.	1.80	1.90
Toluol, commercial 90 p.c.	gal.	1.80	2.05
Xylene, pure	gal.	.50	.55
Xylene, commercial	gal.	.35	.40

INTERMEDIATES AND EXPLOSIVES.

Amido-naphthol-disulfonic acid (H-acid: 1.8.3.6)	lb.	2.80	3.50
Amido-naphthol-sulfonic acid	lb.	—	1.75
p-Amido-phenol	lb.	5.00	6.00
p-Amido-phenol hydrochloride	lb.	5.00	5.50
Amino-azo-benzene	lb.	1.75	1.85
Aniline oil	lb.	.30	.31
Aniline salts	lb.	.34	.36
Aniline for red	lb.	1.12	1.15
Anthraquinone	lb.	—	—
Benzaldehyde	lb.	5.00	5.50
Oil of bitter almonds	lb.	14.00	15.00
Without acid		17.00	18.00
Benzidine	lb.	1.80	1.95
Benzidine sulfate	lb.	1.60	1.70
Benzoic acid	lb.	4.75	5.00
Crude	lb.	3.00	3.50
From gum	lb.	—	7.50
Benzylchloride	lb.	2.25	2.50
Chloro-benzene	lb.	.26	.28
Cumidine	lb.	—	—
Diamido-phenol	lb.	—	—
o-Dianisidine	lb.	—	—
Dichloro-benzene	lb.	.22	.23
o-Dichloro-benzene	lb.	—	—
p-Dichloro-benzene	lb.	.21	.24
Diethyl-aniline	lb.	—	3.50
Dimethyl-aniline	lb.	.55	.60
Dinitro-benzene	lb.	.33	.35
m-Dinitro-benzene	lb.	.45	.50
Dinitrochloro-benzene	lb.	.46	.48
Dinitro-naphthalene	lb.	.44	.75
Dinitro-phenol	lb.	.68	.70
Dinitro-toluene	lb.	.55	.60
Diphenylamine	lb.	.95	1.00
Dioxy-naphthalene	lb.	—	—
Ethyl-aniline	lb.	1.00	1.25
Hydrazine sulfate	oz.	—	.80
Hydroquinone	lb.	2.00	2.10
Hydrazobenzene	lb.	1.50	2.00
Methylanthraquinone	lb.	—	—
Metanilic acid		—	—
Naphthalene-diamine	lb.	—	—
Naphthionic acid, white	lb.	1.60	1.70
a-Naphthol	lb.	—	2.90
b-Naphthol	lb.	.75	.80
Sublimed	lb.	.80	.90
Naphthosulfonic acid		—	—
a-Naphthylamine	lb.	.90	1.05
b-Naphthylamine	lb.	1.75	2.00
Sublimed	lb.	2.75	3.00
p-Nitraniline	lb.	1.15	1.25
Nitrobenzene	lb.	.20	.22
Oil of Mirbane, ref.	lb.	.18	.20
o-Nitrochloro-benzene	lb.	.50	.56
Nitro-naphthalene	lb.	.45	.50
Nitro-naphthol	lb.	—	—
Nitrotoluene	lb.	.50	.55
o-Nitrotoluene	lb.	—	1.00
p-Nitrotoluene	lb.	1.40	1.50
m-Phenylene-diamine	lb.	1.15	1.25
p-Phenylene-diamine	lb.	3.50	4.50
Phthalic acid	oz.	—	.60
Phthalic anhydride	lb.	6.40	8.00
Picric acid, kegs	lb.	.80	1.10
Pyrocatechin resublimed	oz.	—	.80
Resorcinol, cryst., U. S. P.	lb.	16.00	17.00
Technical	lb.	8.50	9.00
Salicylic acid, U. S. P.	lb.	1.45	1.50
Sulfanilic acid	lb.	.34	.35
Tetra-nitro-methyl-aniline	lb.	—	2.50
Tolidine	lb.	3.00	—
Toluidine	lb.	.80	.90
o-Toluidine	lb.	1.00	1.25
p-Toluidine	lb.	1.80	2.00
m-Toluylene-diamine	lb.	1.70	1.75
Xylidine	lb.	.75	.80

SYNTHETIC MEDICINALS. FLAVORS AND PERFUMES.

Acetanilide C. P., bbls.	lb.	.50	.51
Acetphenetidine	lb.	22.00	23.00
Acetyl-salicylic acid, bulk	lb.	—	3.50
Ammonium benzoate	lb.	5.20	5.70
Ammonium salicylate	lb.	3.25	3.50
Antipyrine, bulk	lb.	21.00	21.50
Benzanilide	oz.	—	2.30
Benzonaphthol	lb.	16.00	18.00
Bismuth phenolsulfonate	lb.	—	9.30
Bismuth salicylate	lb.	—	3.15
Bismuth salicylate, 40 p.c.	lb.	—	4.75
Bismuth sub-benzoate	lb.	8.50	9.50
Bismuth subsalicylate, basic, U. S. P.	lb.	—	5.20
Caffeine benzoate	oz.	1.25	1.55
Caffeine salicylate	oz.	.90	1.00
Calcium benzoate	oz.	—	.40
Calcium salicylate	lb.	—	—
Calcium sulfocarbolate	lb.	1.42	1.45
Ethyl benzoate	lb.	—	8.00
Guaiacol salicylate	oz.	1.55	1.80
Lithium benzoate	lb.	8.00	8.25
Lithium salicylate	lb.	4.00	4.40
b-Naphthol benzoate	lb.	11.00	12.00
Phenacetin (Bayer)	oz.	—	2.40
Phenacetin (L. & F.)	oz.	—	2.10
Phenolphthalein	lb.	17.00	18.00
Potassium salicylate	lb.	3.00	3.25
Pyoktanin Blue	oz.	2.50	3.00
Pyramidone	oz.	—	2.50
Saccharin	lb.	[illegible]	39.00
Salol, U. S. P.	lb.	—	1.50
Salipyrine	oz.	—	.80
Salol	lb.	1.95	2.05
Salophen	tube	1.50	1.80
Sodium benzoate, granulated, U. S. P.	lb.	5.00	5.50
Sodium salicylate, U. S. P.	lb.	.85	.90
Strontium salicylate, U. S. P.	lb.	2.70	3.00
Sulfocarbolic acid (30 p.c)	oz.	—	.25
Sulfosalicylic acid	oz.	.65	.75
Tolypyrine	oz.		1.25
Triphenine	oz.	—	.50
Wintergreen oil synthetic, U. S. P.	lb.	.80	.90
Zinc salicylate	lb.	—	[illegible]

PHOTOGRAPHIC DEVELOPERS.

Adurol, 16 oz. bottles	ea	—	10.00
Agfa (intensifier) 2-oz. bottle		—	.40
Amidol 1-oz. bottle	oz.	.65	.75
Dianol 1-oz. bottle	oz.	—	.80
Edinol		—	—
Eikonogen	oz.	—	.45
Glycin, 1 oz. bottle	oz.	—	.80
Hydroquinone	lb.	2.00	2.10
Metacarbol		—	—
Metol	oz.	—	—
Monomethyl-p-amido - phenol (identical with metol)	oz		3.50
Nerol (identical with amidol), 1 oz.	oz.	—	.30
Ortol, 1-oz. bottle	oz.	—	.80
Pyrogallic acid, crystals	lb.	2.95	3.15
Rhodol	lb.	—	—
Rodinal, 3-oz. bottle	ea.	—	.75

ARTIFICIAL COLORS.

Acid Black	lb.	1.10	1.75
Acid Blue	lb.	2.50	4.00
Acid Brown	lb.	1.25	1.50
Acid Fuchsine	lb.	7.00	10.00
Acid Green	lb.	1.75	6.50
Acid Orange	lb.	1.00	1.50
Acid Orange II	lb.	1.00	1.25
Acid Orange III	lb.	1.00	1.15
Acid Red	lb.	2.50	3.55
Acid Scarlet	lb.	2.30	3.50
Acid Yellow	lb.	2.00	3.00
Alizarin Blue	lb.	7.00	8.00
Alizarin Blue, bright	lb.	6.50	7.00
Alizarin Blue, medium	lb.	5.50	6.00
Alizarin Brown, conc	lb.	8.50	10.00
Alizarin Orange	lb.	8.25	9.50
Alpine Red	lb.	5.00	6.50
Alpine Yellow	lb.	6.75	8.00
Auramine	lb.	5.50	7.50
Azo Carmine	lb.	5.50	6.00
Azo Yellow	lb.	1.90	2.25
Azo Yellow, red shade	lb.	3.50	4.00
Aurine	lb.	2.00	2.50
Bismarck Brown Y	lb.	1.30	1.50
Bismarck Brown EE conc	lb.	2.25	3.25
Bismarck Brown 3 R	lb.	2.00	2.25
Bismarck Brown R	lb.	1.60	2.00
Bright Red	lb.	2.75	3.75
Chrysamine Yellow	lb.	1.50	2.50
Chrysoidine	lb.	1.50	1.60
Chrysoidine R.	lb.	2.00	2.25
Chrysoidine Y	lb.	1.75	2.00
Congo Red	lb.	2.90	4.00
Crystal Violet	lb.	7.50	8.00
Direct Acid Orange	lb.	1.10	1.25
Direct Black	lb.	1.15	2.00
Direct Blue	lb.	2.60	3.00
Direct Sky Blue	lb.	6.00	8.00
Direct Brown	lb.	2.00	2.80
Direct Bordeaux	lb.	1.80	2.10
Direct Fast Red	lb.	2.50	3.00
Direct Red	lb.	2.75	3.50
Direct Yellow	lb.	2.60	4.75
Direct Fast Yellow	lb.	2.40	3.00
Direct Violet	lb.	[illegible]	4.50
Eosine	lb.	11.00	15.00
Fast Red, 6B extra	lb.	2.00	3.00
T extra	lb.	—	2.00
Fast Scarlet	lb.	1.75	2.35
Fuchsine	lb.	7.50	12.00
Fur Black, extra	lb.	2.00	3.00
Fur Brown B	lb.	3.00	4.00
Fur Brown GG	lb.	6.00	8.00
Green Crystals	lb.	7.50	8.50
Indigo 20 p.c. paste	lb.	1.50	1.60
Indigotin	lb.	3.85	4.00
Induline	lb.	1.90	2.50
Magenta	lb.	10.00	12.00
Malachite Green	lb.	11.00	12.00
Metanil Yellow	lb.	2.50	3.00
Medium Green	lb.	2.50	4.00
Methylene Blue, tech	lb.	4.50	5.00
Methyl Violet	lb.	4.00	4.75
Naphthol Green	lb.	4.00	4.50
Nigrosine, oil sol.	lb.	.80	1.00
Nigrosine, sp. sol.	lb.	.90	1.00
Nigrosine water sol., blue	lb.	1.60	2.00
Jet	lb.	1.35	1.50
Naphthylamine Red	lb.	6.00	6.50
Oil Black	lb.	1.90	2.10
Oil Green	lb.	2.00	2.50
Oil Orange	lb.	—	2.00
Oil Scarlet	lb.	2.50	3.00
Oil Yellow	lb.	1.80	2.50
Orange, RG	lb.	1.50	2.00
Orange Y, conc.	lb.	1.10	1.50
Ponceau	lb.	2.50	3.00
Quinoline Yellow	lb.	5.00	6.00
Rhodamine	lb.	3.25	6.50
Saffranine	lb.	15.00	20.00
Scarlet 2 R	lb.	3.00	3.25
Soluble Blue	lb.	10.00	14.00
Sulfur Black	lb.	.90	1.10
Sulfur Black 150 p.c	lb.	—	.85
Sulfur Blue	lb.	2.60	3.25
Sulfur Blue-Black	lb.	4.00	4.20
Sulfur Brown	lb.	.50	.60
Sulfur Green	lb.	2.00	3.00
Sulfur Yellow	lb.	1.60	2.00
Tartrazine	lb.	1.90	2.00
Wool Orange	lb.	2.00	3.00
Victoria Blue	lb.	16.00	18.00
Victoria Blue, base	lb.	25.00	26.00
Victoria Green	lb.	13.00	15.00
Victoria Red	lb.	6.50	7.50
Victoria Yellow	lb.	7.00	8.00
Yellow for wool	lb.	2.75	3.00

NATURAL DYESTUFFS.

Annatto, fine	lb.	.33	.34
Seed	lb.	.11	.14½
Carmine No. 40	lb.	4.25	4.75
Cochineal	lb.	.56	.61
Indigo, Bengal	lb.	3.50	4.50
Oudes	lb.	3.00	3.25
Guatemala	lb.	2.35	2.65
Kurpahs	lb.	3.15	3.60
Madras	lb.	1.10	1.15
Madder, Dutch	lb.	.27	.29
Nutgalls, blue Aleppo	lb.	—	—
Chinese	lb.	.25	.26
Persian Berries	lb.	—	—
Turmeric, Madras	lb.	.09½	.10
Aleppey	lb.	.10	.10½
Pubna	lb.	—	—
China	lb.	.07	.07½

DYEWOODS AND RAW MATERIALS.

Algarobilla	ton	140.00	150.00
Barwood	lb.	—	—
Camwood, chips	lb.	.17	.20
Divi-Divi	ton	55.00	66.00
Fustic, sticks	ton	39.00	40.00
Chips	lb.	.04½	.05¼
Hypernic, chips	lb.	.09	.10
Logwood sticks	ton	39.50	40.00
Chips	lb.	.03	.03¾
Myrobolans	ton	60.00	65.00
Quercitron Bark No. 1	ton	—	50.00
No. 2	ton	—	28.00
Red Saunders, chips	lb.	.15	.17
Sumac, Sicily, 27 p.c tannin	ton	85.00	95.00
Virginia, 20 p.c. tannin	ton	55.00	57.00

EXTRACTS.

Archil, double	lb.	.14¼	.16¼
Triple	lb.	.19½	.21
Concentrated	lb.	.28¼	.30¼
Chestnut, 25 p.c. tannin	lb.	.02¼	.02¾
Clarified, 25 p.c. tannin	lb.	.02½	.03
Cutch, Rangoon, boxes	lb.	.12½	.13½
Liquid	lb.	.08½	.09
Tablet	lb.	.10	.12
Cubear, French	lb.	—	—
English	lb.	19	.24
Concentrated	lb.	—	.38
Flavine	lb.	1.00	1.50
Fustic	lb.	.11	.12
Gall	lb.	—	.18
Gambier, 25 p.c. tannin	lb.	.10	.10½
Common	lb.	16	.16½
Cubes No. 1	lb.	.23	.24
No. 2	lb.	21	.23
Hematine	lb.	.08	.10
Crystals	lb.	.24	.34
Hypernic, liquid	lb.	.18	.20
Indigo, natural for cotton	lb.	.50	.52
For wool	lb.	.28	.30
Indigotin, 100 p.c. pure	lb.	—	5.50
Logwood, solid	lb.	.18½	.19½
Crystals	lb.	.19	.24
51° Tw.	lb.	.08	.10
Myrabolans, 25 p.c. tannin	lb.	.06	.07
Solid, 50 p.c. tannin	lb.	.10	.11
Osage Orange— Powdered, Aurantine	lb.	—	.25
Paste	lb.	.06	.12
Persian Berries	lb.	—	—
Quercitron	lb.	.07	.11
Sumac, liquid, 25 p.c. tan	lb.	.06	.10½

DYEING ACCESSORIES.

Acetic acid, 28 p.c.	lb.	.05	.06
56 p.c.	lb.	.10½	.11½
Glacial, 99 p.c.	lb.	.36	.38
Albumen, Egg	lb.	1.00	1.05
Blood, imported	lb.	.55	.75
Domestic	lb.	.45	.50
Alum, ammonium, lump	lb.	.04¾	.05¼
Alum, chrome ammonium	lb.	.18	.19
Alum, chrome potassium	lb.	.30	.32
Alum, chrome sodium	lb.	.12	.12½
Alum, potassium, lump	lb.	.07¾	.08½
Aluminum acetate	lb.	.95	1.00
Aluminum chloride, liq.	lb.	.04½	.05
Aluminum sulfate, techn.	lb.	.02	.02⅛
Aluminum sulfate, iron free	lb.	.03½	.03¼
Ammonium vanadate	lb.	7.00	—
Bleaching Powder, 35 p.c.	lb.	.02	.02¼
Borax, cryst.	lb.	.07¼	.07½
Citric acid, crystals	lb.	.72	.75
Powdered	lb.	.72½	.75
Copper subacetate (verdigris)	lb.	.40	.42
Copper sulfate (blue vitriol) 99 p.c.	lb.	.09½	.09¾
Dextrine, corn	100 lbs.	—	5.90
Dextrine, imported potato	lb.	.13	.14
Dextrine, domestic potato	lb.	.09	.10
Ferric sulfate, basic (nitrate of iron), comm.	lb.	.02½	.03
True		.05	.06
Ferrous acetate (pyrolignite)	lb.	—	—
Ferrous sulfate (copperas)	100 lb.	1.00	1.05
Formic acid, 75 p.c.	lb.	.35	.40
Glanber's salt (sodium sulfate)	100 lb.	.70	.75
Glucose	100 lb.	2.50	2.55
Glycerin, C. P.	lb.	.62	.62½
Gum arabic, firsts	lb.	.45	.50
Seconds	lb.	.40	.43
Sorts, amber	lb.	.21	.22
White	lb.	.35	.36
Gum tragacanth, Alep., firsts	lb.	2.28	2.37
Seconds	lb.	1.94	2.00
Thirds	lb.	1.65	1.85
Sorts	lb.	.75	.90
Hydrochloric acid (muriatic) 18°	lb.	.01⅜	.01½
20°	lb.	.01½	.01¾
22°	lb.	.01¾	.02
Lactic acid, 22°	lb.	.04½	.05
44°	lb.	.11	.12
Nitric acid, 36°	lb.	.05¾	06¼
38°	lb.	.06¾	.07¼
40°	lb.	.07	.07⅛
42°	lb.	.07½	.08
Oxalic acid	lb.	.47	.48
Potassium antimony tartrate (tartar emetic)	lb.	.57	.59
U. S. P.	lb.	.62	64
Potassium bichromate	lb.	.36	.37
Potassium ferricyanide (red prussiate)	lb.	2.60	2.80
Potassium ferrocyanide (yellow prussiate)	lb.	.96	1.00
Potassium tartrate, acid (cream of tartar)	lb.	.48½	.49
Prussian blue	lb.	.80	.90
Soluble	lb.	.95	1.00
Sago flour	lb.	.04¾	.05
Soda ash, 58 p.c.	100 lbs.	2.70	2.95
Soda, caustic, 76-78 p.c.	100 lbs.	6.00	7.00
Sodium acetate	lb.	.09	.10
Sodium arsenate	lb.	.25	.60
Sodium bichromate	lb.	.15½	.16¾
Sodium bisulfite	lb.	.03½	.04
Sodium chlorate	lb.	.25	.26
Sodium ferrocyanide (yellow prussiate)	lb.	.30	.35
Sodium nitrite techn.	lb.	.38	.42
U. S. P.	lb.	.40	.44
Sodium phosphate, com	lb.	.04¾	.05
Sodium silicate, liquor 40° Bé.,	100 lbs.	1.05	1.25
Crystals	lb.	.02¼	.02½
Sodium sulfide, 60 p.c., fused	lb.	.03	.03¼
Crystals, 30 p.c.	lb.	.02	.02¼
Sodium Thiosulfate (hyposulfite)	100 lbs.	1.60	1.75
Soluble oil, 50 p.c.	lb.	.10	.12
75-85 p.c.	lb.	.14	.16
Stannous chloride (tin crystals),	lb.	.40	.40½
Stannic chloride (tin bichloride), 50°	lb.	.19¾	.20
Starch, corn, pearl	100 lbs.	4.95	5.05
Potato	lb.	.13	.14
Rice	lb.	.08	.10
Wheat	lb.	.05	.06
Sulfuric acid, 60°	ton	20.00	22.00
66°	ton	29.00	31.00
Oleum, 20 p.c.	ton	38.00	40.00
Tartaric acid, crystals	lb.	76	.82
Turkey Red oil	lb.	.14	.16
Zinc dust, 350 mesh	lb.	.18	.25

DETERMINATION OF THE EXPLOSIBILITY OF PYRITES

And the Effect of this Quality Upon Its Available Sulphŭr and the Sulphur Contents of its Cinders

By C. R. Gyzander *

WHEN one buys pyrites as a source of sulphur for the manufacture of sulphuric acid, high contents of sulphur in the ore is not necessarily a guarantee of its fitness, since other characteristics have a bearing on the amount of sulphur available for the production of SO_2. So, for example, the explosive property of some varieties of pyrites, while rather an aid to high efficiency when the ore is burned as fines, is a great drawback when the ore is to be burned as lump ore, since the dust which the explosion of the ore causes, fills up the interstices between the lumps and thus prevents the free access of air, in consequence of which the combustion is incomplete, the resulting cinders high in sulphur, while the available sulphur is low.

Again, some ores consist of small crystals or particles of pyrites and sand or silica, loosely cemented together and readily broken up during the process of combustion, thus forming dust which may clog and render the ore unsuitable as a lump ore.

These two qualities are easily exhibited by heating a lump of the ore on a clay triangle over the naked flame of a Bunsen burner while a screen of fine netting is placed over the lump to prevent the scattering of the small pieces of ore if it does explode.

The quantitative determination of its explosibility or crumbling quality is accomplished by heating the ore in a covered dish at a high temperature, until crumbling or explosibility has ceased, then cooling, screening and weighing the ore, originally selected to remain on a certain size screen while passing through a next larger size.

Call the total weight of the burnt ore A grams while the portion that passes through the smaller screen is B; then the explosibility or crumbling of the ore is $\frac{B}{A}$ 100%.

By the use of graded sieves, the percentage of the various sizes resulting from the explosion may be determined.

Some authorities claim to destroy or minimize the explosive effect by a gradual preheating of the ore, but my own observations in this direction do not confirm that statement, possibly because the exact conditions of a successful preheating were unknown.

Twenty-four hours preheating at temperatures from 120 to 340°C (at which temperature explosibility seems to commence) has no apparent effect in diminishing the explosive quality.

Some users of ore have offered as an explanation for the explosibility of a pyrites that its mass is subject to an unequal internal strain, but the fact that preheating seems to have no effect in anealing or equalizing this strain, even up to temperatures at which it begins to explode, seems to argue against this theory.

Dr. Lunge suggests that the explosibility is due to pockets of CO_2 gas, the expansion of which, during the process of combustion, causes the breakage of the lump with more or less explosive violence.

The correctness of this view seems to be borne out by the fact that the explosibility diminishes as the ore is crushed down in size, a process which naturally would tend to destroy any existing pockets through cleavage.

If actual values with reference to explosibility are sought the ore should be heated in the same size that it is to be used in the burners, that is, a definite weight of ore should be graded by screening and each portion tested, separately, for explosibility.

But this would involve the use of a cumbrous laboratory apparatus, while a relative explosibility, that is, the explosibility of the ore of a uniform but small size, would be equally as valuable as a means of comparison of two grades of ore, while the laboratory apparatus would be more manageable.

For a comparative test therefore, the ore may be crushed to pass a 7/16 but remain on a 5/16 round hole screen, when, after heating, what passes through the 5/16 screen is explosive ore. This portion may now be graded to determine dust qualities.

As example of the application of this explosive test I quote the following cases:

The ore is Spanish "Perrunal" and Rio Tinto washed ore, of which 240 grams, crushed to pass a 7/16 but to remain on a 5/16 round hole screen, were heated in a covered agate wash bowl placed in a suitable ring tripod and heated with a large Meker

---

*With the Merrimac Chemical Company, Boston, Massachusetts.

burner for ½ hour, when all cracking had ceased. After cooling, the ore was sifted with the following result:

LOT NO. 1.

	Grams.
Remaining on 5/16 round hole screen	232.5
Remaining on 10 mesh sieve	3.8
Remaining on 20 mesh sieve	.2
Through 20 mesh sieve	.2
	236.7

corresponding to

Non-explosive ore	98.22%
Explosive ore	1.78%
	100.00

of which

1.60% remained on 10 mesh
.09% “ “ 20 “
.09% passed 20 “

1.78%

LOT No. 2.

On 5/16 round hole screen	184.8	grams
“ 10 mesh sieve	20.8	“
“ 20 “ “	4.7	“
Through 20 mesh sieve	7.9	“
	218.2	

corresponding to

Non-explosive ore	84.69%
Explosive ore	15.31%
	100.00

of which

9.53% remained on 10 mesh
2.15% “ “ 20 “
3.63% passed 20 “

15.31

LOT No. 1, RIO TINTO WASHED ORE.

On 5/16 round hole screen	209.5	grams
“ 10 mesh sieve	9.2	“
“ 20 “ “	1.0	“
Through 20 mesh sieve	3.1	“
	222.8	“

corresponding to

Non-explosive ore	94.03%
Explosive ore	5.97%
	100.00

of which

4.12% remained on 10 mesh
.44% remained on 20 mesh
1.41% passed 20 mesh

LOT No. 2.

On 5/16 round hole screen	182.0	grams
“ 10 mesh sieve	40.0	“
“ 20 “ “	1.0	“
Through 20 mesh sieve	3.0	“
	226.0	“

corresponding to

Non-explosive ore	80.6%
Explosive ore	19.4%
	100.0%

of which

17.7% remained on 10 mesh
.4% remained on 20 mesh
1.3% passed on 20 mesh

This goes to show what a wide difference the same kind of ore does exhibit as to explosibility and the same holds as to its cinder tests which, with the Perrunal ore, varies from less than 1% for a non-explosive ore up to 5 and 6% for explosive ore, while the Rio Tinto cinders vary from 4 to 10%, due to choking with dust, since these cinder tests refer to the ores burnt as lump ore.

Though these explosive tests do not give absolute figures, they indicate that one may reasonably look for a difference in the cinder values of such ores when burned as lump ore. What exact relation this relative explosion test bears to the cinder value is not known, since no systematic determinations have been carried out on separate lots, but whatever relation does exist, can only be of a local significance, since a lump burner with a large sectional area and shallow depth will be less affected by the dust than one of small sectional area and greater depth, for the chances are that the latter will retain more of the obstructive dust than the former. I think the appended figures may speak a word of advice to some one and thus be a profitable aid in helping him to judge of the fitness of the ore for use as a lump ore in the production of SO_2. It may be that the difference in the sulphur contents of the cinders of an explosive ore referred to burners of a certain construction, when compared with what should be the legitimate sulphur content of this ore if it were non-explosive, would more than pay for the cost of crushing the lump into fines, which is the most effective form in which an explosive ore could be handled.

That the size of the lump does cause a difference in the explosive test will be seen from the following figures, which were obtained with a specially selected explosive Perrunal ore.

LUMP, SIZE OF HEN'S EGGS.

Ore exploded	100.0%
of which	
On 5/16 round hole screen	16.23%
On 10 mesh sieve	49.23%
On 20 mesh sieve	16.16%
Through 20 mesh sieve	18.38%
	100.00%

CRUSHED TO PASS 1" ROUND HOLE AND REMAIN ON ¾" ROUND HOLE SCREEN.

Ore exploded	89.01%
of which	
On 5/16 round hole screen	41.90%

On 10 mesh sieve	22.87%
On 20 mesh sieve	8.71%
Through 20 mesh sieve	15.53%
	89.01%

CRUSHED TO PASS 7/16 AND REMAIN ON 5/16 ROUND HOLE SCREEN.

Ore exploded	37.42%
of which	
On 10 mesh sieve	26.63%
On 20 mesh sieve	4.76%
Through 20 mesh sieve	6.03%
	37.42%

CRUSHED TO PASS NO. 6 MESH AND REMAIN ON NO. 10 MESH SIEVE.

Ore exploded	7.71%
of which	
On 20 mesh sieve	6.33%
Through 20 mesh sieve	1.38%
	7.71%

Or the explosibility has dropped from 100 to 7.71% by varying the size of the lump from that of a hen's egg to that of the size of coarse fines.

But even though the ore is non-explosive or non-crumbling it still does not follow that it is economical as a source of sulphur, since its burning qualities may be poor; that is, the rate at which it gives up its sulphur, the rate of change of the ore, is low, or, as it is usually expressed, it burns more or less freely, and it is evident that, since the ore is subject to the process of burning, whatever it may be, for a definite length of time, the more freely burning ore will have less sulphur remaining unburnt in a given time than the ore that burns more slowly, if such a quality does exist as an adjunct to a lot of pyrites.

Experience has proved that it does, and therefore the determination of the rate of change of combustion and its application to the determination of available sulphur as well as the sulphur contents of the cinders, will now be described. .

The method, in brief, consists of burning a convenient amount of the ore, crushed to pass a 50 mesh sieve in a standard size dish, under standard conditions of temperature, for various intervals of time, and determining the amount of unburnt sulphur in the resultant cinders, which furnishes the data necessary for the calculation of the rate of change of the ore.

Since the combustion of pyrites, like most other chemical reactions, is influenced by temperature, it is absolutely necessary to have the analytical temperature conditions constant at all times. Further, the ore which is used as a standard for comparison should be a fines ore, or a non-explosive, non-crumbling lump ore, of which the sulphur value of its cinders is also known.

The manipulative details are as follows:

As a source of heat I use an electric furnace which attains a temperature of 1,000° F. and here I heat 2 grams of ore, crushed to pass a 50 mesh sieve and accurately weighed, in small, thin walled, electro-quartz dishes of uniform size and thickness. The ones I use hold 10 c.c. and have a thickness of wall of 1/32″.

Three of them are placed, close together, in a sheet iron rack with handle, the exact size of the furnace, having holes which fit the respective dishes, so that they touch the bottom of the oven when placed there. After 15-minute intervals of time, or longer if necessary, they are lifted, separately, out of the furnace with crucible tongs, while an empty dish takes its place in the furnace, so as to insure that the circulation of the heat remain as nearly as possible constant.

The reaction is stopped by placing 5 grams Na_2CO_3 on top of the dish as soon as it comes out of the furnace, and it is then left to cool.

There thus results three samples of cinders, having been exposed for known intervals of time, say for 15, 30 and 45 minutes respectively, and the sulphur contents of which is determined, by transferring each dish of cinders and Na_2CO_3 to a roomy platinum dish, breaking up the cake of cinders with a flattened, thick glass rod, adding 5 grams $NaNO_3$, mixing and fusing to oxidize the sulphur.

After cooling it is lixiviated with water, filtered, filtrate acidified with excess of HCl in covered glass dish, CO_2 boiled off, solution evaporated to dryness, the dry mass dissolved in water, acidified with HCl, filtered from SiO_2, precipitated by $BaCl_2$ and this, washed, dried, ignited, cooled and weighed, from which weights we ascertain its sulphur content, which corresponds to $a - x$ in the equation. Whether we regard the combustion of the pyrites merely as a distillation of its sulphur contents, or as an oxidation process, or both, the reaction may be treated as one of the first order, since, even in the case of the oxidation, both in the analytical and practical operation, the burning ore is continually being treated with fresh quantities of air, in consequence of which the oxygen phase of the reaction is constant and hence only the sulphur undergoing change. The rate of change is therefore expressed by the differential equation

$$(1) \quad \frac{dx}{dt} = K(a - x)$$

which when integrated for $x = O$ when $t = O$ becomes

$$(2) \quad \frac{1}{t} \log_e \frac{a}{a - x} = K$$

Here (a) represents the amount of sulphur in the 2 grams of ore used.

From equation 2 we see that, since the amount of action, or (x), in a given time (t), is proportional to (a), other conditions being constant, (m) times as much ore, or (ma) grams, would give (m) times as much action or (mx) in the time (t), hence the logarithmic factor of the equation becomes:

$$\frac{ma}{ma - mx} = \frac{m\,a}{m(a - x)} = \frac{a}{a - x} \text{ or constant}$$

Therefore the value of K is independent of the value of (a), and so we may use the constant quantity 2 grams of ore, even if they do not always carry the same amount of sulphur. The value of K is still proportional to the velocity of the reaction, if the temperature conditions are constant, or any other conditions that may have an influence on the reaction are constant, like size and thickness of dishes used for the combustion.

As a sample for comparison I use a non-explosive, non-crumbling variety of perrunal ore, which gave the following tests:

Sulphur in ore....................	50.5%
Sulphur in cinders................	1.0%

$$2 \text{ grams ore} = \frac{50.5}{100} \times 2 = 1.01 \text{ grams sulphur} = a$$

t	a — x	K_{10}
15	.27163	.03802
30	.06351	.04004
45	.01813	.03879

Average K_{10}....... .03895

K_{10} represents the value of the velocity constant when referred to common logarithms in equation 2. With reference to natural logs it is to be multiplied by 2.30259, hence $K_e = 2.30259$, $K_{10} = .089686$.

Since K is independent of the value of (a) we may refer it to 100 grams of ore when determining available sulphur and cinder sulphur, in preference to using 2 grams, or the analytical amount used in determining K.

The composition of the cinders is, in all probability, a mixture of Fe_2O_3 and Fe_3O_4, but we will assume them to be Fe_2O_3 as sufficiently correct for our purpose.

The next question is, then, how long will we have to burn 100 grams of the ore, under the same conditions of temperature and so on as prevailed wher determining K_e, in order that the cinders may contain 1% sulphur?

If to do this x grams of sulphur burn off, the cinders will be $100 - x + \frac{48}{128.24} x$, since for every 4 atoms of sulphur burnt off 3 atoms of oxygen are taken up to form Fe_2O_3, and we have the proportion

$$\left(100 - x + \frac{48x}{128.24}\right) : (50.5 - x) = 100 : 1$$

$x = 49.81\%$ available sulphur burnt off

$a - x = .69\%$ sulphur left in cinders

$a = 50.50$

Substituting these values in equation 2 we have, when using common logs:

$$\frac{2.30259}{t} \log \frac{50.5}{.69} = .089686$$

$$t = 48 \text{ minutes}$$

That is to say, 48 minutes is the time we must refer the burning of all ores, so long as their rate of change or the value of K_e has been determined in the electric furnace.

If for some reason this has to be given up, the value of K_e will have to be re-established for the new conditions, before we may make any computations as to cinder values or available sulphur.

Another lot of Perrunal ore tested as follows:

Sulphur in ore....................	49.3%
Sulphur in cinders................	2.3%

$$2 \text{ grams ore} = \frac{49.3}{100} \times 2 = .9860 = a$$

t	a-x	K_{10}
15	.37145	.02826
30	.10163	.03296
45	.02373	.03596

Average K_{10}.. .03239

$K_e = 2.30259 \qquad K_{10} = .07458$

100 grams of this ore, burning as above for 48 minutes would leave a-x sulphur for cinders and we have:

$$\frac{2.30259}{48} \log \frac{49.3}{a\text{-}x} = .074581$$

$a\text{-}x = 1.37$ grams sulphur left in cinders

$x = 47.93$ grams available sulphur

$A = 49.30$

$$100\text{-}47.93 + \frac{48}{128.24} \times 47.93 = 70.01 \text{ grams } Fe_2O_3$$

cinders

$$\frac{1.37}{70.01} \times 100 = 2.0\% \text{ sulphur in cinders}$$

Found = 2.3% sulphur in cinders

The above value of K_{10} is not in very good agreement as a constant, but the calculations show that it is near enough for this case. Had the sulphur value of the cinders been required before burning the ore it would have been a safer practice to repeat the analytical operation with a view to obtaining better agreeing values of K.

A sample of Eustis fines contained.

Sulphur in ore....................	42.98%
Sulphur in cinders................	2.70%

$$2 \text{ grams ore} = \frac{42.98}{100} \times 2 = .8596 = a$$

t	a-x	K_{10}
20	.19164	.03259
40	.03952	.03343
60	.03468	.02323

Average K_{10} .02975

$K_e = 2.30259 \qquad K_{10} = .06850$

48 minutes burning to Fe_2O_3 cinders.

$$\frac{2.30259}{48} \log \frac{42.98}{a\text{-}x} = .06850$$

Sulphur in cinders......... $a\text{-}x = 1.60$
Available sulphur.......... $x = 41.38$
$a = 42.98$

$$100\text{-}41.38 + \frac{48}{128.24} \times 41.38 = 74.06\%\ Fe_2O_3 \text{ cinders}$$

$$\frac{1.60}{74.06} \times 100 = 2.16\% \text{ sulphur in cinders}$$

Found = 2.70% sulphur in cinders.

Another lot of Eustis fines tested,

Sulphur in ore .... 44.0 %
Sulphur in cinders................ 2.70%

$$2 \text{ grams ore} = \frac{44.6}{100} \times 2 = .8800 = a$$

t	a-x	K_{10}
15	.35526	.02626
30	.15865	.01813
45	.04056	.02969

Average K_{10} .02798

$K_e = 2.30259\ K_{10} = .06443$

Burning 48 minutes to Fe_2O_3 cinders.

$$\frac{2.30259}{48} \log \frac{44}{a\text{-}x} = .06443$$

Sulphur in cinders........ $a\text{-}x = 2.00$
Available sulphur......... $x = 42.00$
44.00

$$100-42 \times \frac{48}{128.24} + 42 = 73.84 \text{ grams } Fe_2O_3 \text{ cinders}$$

$$\frac{2.00}{73.87} x100 = 2.70\% \text{ sulphur in cinders}$$

Found=2.70% sulphur in cinders

A Eustis lump ore tested,

Sulphur in ore............ 41.92%
Sulphur in cinders......... 3.20%

$$2 \text{ grams ore} = \frac{41.92}{100} \times 2 = .8384 = a$$

t	a-x	K_{10}
15	.29676	.03007
30	.12453	.02761
45	.03663	.03021

Average K_{10}.... .029296

$K_e = 2.30259$ $K_{10} = .06746$

Burning 48 minutes to Fe_2O_3 cinders

$$\frac{2.30259}{48} \log \frac{41.92}{a\text{-}x} = .06746$$

Sulphur in cinders........ $x = 40.28$
Available sulphur......... 43.24%
$a = 41.92$

$$100 - 40.28 \frac{48}{128.24} x\ 40.28 = 74.79 \text{ grams } Fe_2O_3 \text{ cinders.}$$

$$\frac{1.64}{74.79} x100 = 2.19\% \text{ sulphur in cinders}$$

Found 3.20% sulphur in cinders

Another lot of explosive Eustis lump ore tested as follows:

Sulphur in ore............ $a\text{-}x = 1.64$
Sulphur in cinders......... 4.10%

$$2 \text{ grams ore} = \frac{43.24}{100} + 2 = .8648 = a$$

t	a-x	K_{10}
15	.28714	.03192
30	.06063	.03847
45	.04145	.02932

Average K_{10} .03323

$K_e = 2.30259$ $K_{01} = .07652$

Burning 48 minutes to Fe_2O_3 cinders

$$\frac{2.30259}{48} \log \frac{43.24}{a\text{-}x} = .07652$$

Sulphur in cinders......... $a\text{-}x = 1.09\%$
Available sulphur......... $x = 42.15\%$

$$100-42.15 + \frac{48}{128.24} x\ 42.15 = 73.94 \text{ grams } Fe_2O_3 \text{ cinders}$$

$$\frac{1.09}{73.94} x\ 100 = 1.33\% \text{ sulphur in cinders.}$$

Found 4.10% sulphur in cinders

That is, burnt as fines the ore would have left only 1.33% sulphur in the cinders, but on account of the explosive dust and clogging this rose to 4.10%.

I will now append two more sets of determinations made in 1908.

In August of that year, Carridad lump ore was burned at one set of burners, giving high sluphur, while Eustis lump was being burned at another set of burners with the normal sulphur test in the cinders. As it happened that men with less experience were engaged on the burners where the Carridad ore was burned it was not unreasonable to suspect that the men, either from laziness or ignorance, had not given the proper attention to breaking and charging that they should, and so I tried the determination of the rate of change of the two ores, with the expectation that the suspicions regarding the men's guilt would be confirmed.

The results, however, entirely exonerated the men from all blame and showed the cause to be due to the poor burning quality of the ore itself. At that time I did not have the electric furnace, but made the determination in one and the same dish placed on a tripod and heated with a small Meker burner, shielded from draughts by a sheet iron hood.

The results were as follows:

EUSTIS LUMP ORE

Sulphur in ore..............45.8%
Sulphur in cinders........... 3.0%

$$2 \text{ grams ore} = \frac{45.8}{100} + 2 = .91.60 = a$$

t	a-x	K_{10}
15	.3705	.02620
30	.1893	.02282
45	.0446	.02916

Average K_{10} .02606

$_e = 2.30250$ $K_{10} = .06001$

$$(100 - x + \frac{48}{128.24} x) : (45.8 - x) = 100 : 3$$

$x = 43.62$ grams sulphur burnt off
$a - x = \;\;2.18$ grams sulphur in cinders

$a = 45.80$

$$\frac{2.30259}{t} \log \frac{45.8}{2.18} = .06001$$

$t = 51$ minutes

CARRIDAD ORE

Sulphur in ore.............. 43.7%
Sulphur in cinders..........9.70%

$$2 \text{ grams or} = \frac{43.7}{100} \times 2 = .8740 = a$$

t	a-x	K_{10}
15	.5027	.01601
30	.3243	.01435
45	.1945	.01450

Average K_{10} .01495

$K_e = 2.30259$ $K_{10} = .03442$

$$\frac{2.30259}{51} \log \frac{43.7}{a-x} = .03442$$

$a - x = \;\;7.55$ grams sulphur left in cinders
$x = 36.15$ " " burnt off

$a = 43.70$

$$100 - 36.15 + \frac{48}{128.24} \times 36.15 = 76.91 \text{ grams cinder}$$

$$\frac{7.55}{76.91} \times 100 = 9.80\% \text{ sulphur in cinders}$$

Found = 9.70% sulphur in cinders

Again, in November of that same year, some of this Carridad ore was burned as fines with such unusual low sulphur test in the cinders, compared with the lump ore, that now the suspicion arose as to the accuracy of the cinder samples or the cinder test.

Again the determination of the rate of change of the fines ore exonerated the parties concerned, and placed the explanation on the better burning qualities of the fines ore.

As there was not any surety that the flame could be adjusted to the exact conditions prevailing when the test of the lump ores was made the preceding August, I chose for comparison a sample of Eustis fines ore burned the same month as the Carridad fines.

The results were as follows:

EUSTIS FINES ORE.

Sulphur in ore.................... 46.1%
Sulphur in cinders................ 2.6%

$$2 \text{ grams ore} = \frac{46.1}{100} \times 2 = .9220 = a$$

t	a-x	K_{10}
15	.3962	.0247
30	.2120	.0214
45	.0675	.0253

Average K_{10} .0238

$K_e = 2.30259$ $K_{10} = .0548$

$$(100 - x + \frac{48}{128.24} x) : (46.1 - x) = 100 : 2.6$$

$x = 44.22$ grams sulphur burnt off
$a - x = \;\;1.88$ grams sulphur left in cinders

$a \quad = 46.10$

$$\frac{2.30259}{t} \log \frac{46.1}{1.88} = .0548$$

$t = 58$ minutes

CARRIDAD FINES.

Sulphur in ore..................... 42.2%
Sulphur in cinders................ 2.1%

$$2 \text{ grams ore} = \frac{42.2}{100} \times 2 = .8440 \text{ grams} = a$$

t	a-x	K_{10}
15	.3628	.0245
30	.1941	.0213
45	.0621	.0252

Average K_{10} .0236

$K_e = 2.30259$ $K_{10} = .0543$

$$\frac{2.30259}{58} \log \frac{42.2}{a-x} = .0543$$

$a - x = \;\;1.80\%$ sulphur left in cinders
$x = 40.40\%$ sulphur burnt off

$a \quad = 42.20$

$$100 - 40.4 + \frac{48}{128.24} \times 40.4 = 74.72 \text{ grams cinders}$$

$$\frac{1.80}{74.72} \times 100 = 2.40\% \text{ sulphur in cinders}$$

Found 2.10% sulphur in cinders

It is well known that as regards available sulphur in pyrites no method has hitherto been presented that agrees at all with practice.

To account for the low yield of available sulphur it is the custom, in some places at least, to determine such heavy metals as lead, copper and zinc and deduct from the total sulphur that equivalent to sulphates of these metals, but even so, there is usually no agreement with practical yields, and as the sulphates of these heavy metals are all decomposable at a bright red heat, the temperature of the burners.

it is evident that such a practice is faulty, even if it occasionally should seem to agree with practical results.

The only reliable method of arriving at the available sulphur content of a pyrites is, as has been shown, the determination of the rate of change of the ore, compared with some other ore that works normally and the available sulphur of which is known..

Furthermore, this determination serves as a check upon results already obtained and so helps to place the true explanation upon them instead of subjecting them to mere suspicions, which, though seemingly reasonable, may still be untrue.

PROGRAM FOR THIRD CHEMICAL EXPOSITION IS NEARING COMPLETION

All things indicate that the Third National Exposition of Chemical Industries at the Grand Central Palace, New York, during the week of Sept. 24th, will far outstrip its predecessors in magnitude and general interest.

At the last exposition two floors of the big building were occupied by the 187 exhibitors, while this year three floors, possibly more, will be occupied. Already the list of exhibitors contains 250 names of companies engaged in practically every field of industry.

The program now forming shows that on Wednesday. Sept. 26th, the Technical Association of Pulp and Paper Industry will meet at the exposition. On Thursday evening the American Institute of Chemical Engineers will meet, and Friday evening has been set aside for the American Chemical Society's New York Section.

Opening addresses will be made on that occasion Monday, Sept. 24th, at 2 p. m., by Dr. Charles H. Herty, chairman of the Advisory Committee of the exposition, and editor of the Journal of Industrial and Engineering Chemistry. Prof. James Stieglitz, president of the American Chemical Society; Dr. Colin G. Fink, president of the American Electrochemical Society, and Dr. G. W. Thompson, president of the American Institute of Chemical Engineers, will also address those present on the opening day.

Among other speakers on the program for other days are Mr. W. S. Kies, vice-president of the National City Bank, New York, who will speak on "The Development of Export Trade with South America"; Prof. Marston Taylor Bogert, chairman of the Chemistry Committee, National Research Council, who will speak on "The Operation and Work of the National Research Council for the National Weal," and Dr. Leo H. Baekeland, of the Naval Consulting Board, who will have for his topic "The Future of American Chemical Industry."

One day has been set aside for discussing a symposium of our national resources as opportunities for chemical industries, and among the speakers will be: Mr. C. H. Crawford, assistant to the president of the Nashville, Chattanooga & St. Louis Ry.; Dr. Y. V. Kelsey, chemist and industrial agent for the Carolina, Clinchfield & Ohio Ry.; Dr. E. A. Schubert, mineralogist-geologist, Norfolk & Western Ry.; and Dr. T. P. Maynard, mineralogist-geologist, Central of Georgia Ry. and Atlantic Coast Line Ry.

The motion picture program will be one of wide interest. The American Cyanamid Co. and the General Electric Co. have already arranged to exhibit their films, while the Bureau of Commercial Economics at Washington will also supply many toward completing the range of industrial films.

A NEW PROCESS FOR THE PRODUCTION OF PHTHALIC ACID AND ITS ANHYDRIDE

The United States Department of Agriculture announces that the Color Investigation Laboratory of the Bureau of Chemistry, of this department, has perfected, on a laboratory scale, a new process for the manufacture of phthalic acid and phthalic anhydride. This process, as carried out in the laboratories, appears so promising that it is thought that some manufacturers of chemicals and dyestuffs in this country may be able to supply their demands for these compounds by this process, provided the process can be reproduced upon a technical scale so as to obtain results commensurate with the laboratory investigations.

With a view to helping the chemical industry of this country, the Department of Agriculture hereby announces that it is ready to assist manufacturers who wish to produce these compounds. The expenses of the technical installation and of the labor and materials necessary will of necessity be borne by the firm, individual, or corporation wishing to manufacture the products. The chemists of the Color Investigation Laboratory will assist with expert advice, etc. The department reserves the right to publish all the data obtained from the technical experiments.

Since it seems very desirable that phthalic acid and phthalic anhydride be made available in large quantity in this country at the earliest possible moment. this offer of assistance will not be held open by the department for an indefinite period.

George H. Segal Co. to Build New Plant.

A new chemical manufacturing plant will be established on Meadow Street, Kearney meadow section, Newark, N. J., by George H. Segal Co., 95 William St., New York City.

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By Carleton Ellis and A. A. Wells.[*]

This Is the Fifth Installment of an Article Dealing with Investigations Conducted by the Writers Into the Possible Application of Ultra Violet Light. The Present Installment Discusses the Work of Other Investigators in Connection with the Effectiveness of Its Rays for the Sterilization of Transparent and Opaque Liquids, Emulsions, Fats, Etc.; Their Efficiency as Compared with Ozone, and the Cost of Municipal Water Sterilization by Ultra Violet Light. Part VI. Will Appear in the Next Issue.

PART V

Sterilization of Liquids.

THE application of ultra violet rays to the sterilization of liquids, such as water or milk, has been the subject of numerous investigations and a considerable number of patents have been issued for processes of sterilization and for apparatus suitable for carrying out the sterilization of liquids on an industrial scale, by means of ultra violet light.

According to *von Recklinghausen* (Journal, Franklin Institute, 1914, 681) practically every source of light produces, together with visible light rays, some of the wave lengths shorter than those which are perceptible to the human eye. The shortest wave length which the human eye is capable of receiving is about .3969 μ, but it is claimed that certain eye structures have been able to preserve light rays somewhat shorter than this.

One of the typical characteristics of ultra violet light rays shorter than .3969 μ is its bactericidal or sterilizing power. That the longer light rays do not sterilize to any material extent is probably due to the fact that living beings have the power to accustom themselves to the conditions under which they must live and inasmuch as these longer light waves are received from the sun, living creatures have fortified themselves against their action.

A great deal of our knowledge of the sterilizing effect of ultra violet light is due to *Ward*, who first analyzed the biologic effect of the light spectrum by exposing an affected agar plate to the entire range of the solar spectrum with the result that colonies grew quite rapidly at the red, while at the blue or ultra violet end no colonies were formed.

These tests were made in vacuo as well as in the air, with practically the same results. Ward also sterilized water of the Thames, by exposing it to ultra violet light.

Finsen and his pupils did a large amount of work on sterilization and one of the pupils first proposed the use of the ultra violet light for the sterilization of milk as well as other liquids. Finsen's researches did not meet with any immediate technical application probably due to the source of light which he was compelled to use, as the mercury quartz lamp did not exist at that time.

In the sterilization of water, von Recklinghausen states that usually a small part of a second (about 1/20) is sufficient to cause the death of microbes in case they can be exposed close enough to the source of light. The sterilizing power of ultra violet light is inversely proportional to the distance between the light and the material to be sterilized. In sterilization by means of heat it is well recognized that certain spores and bacteria have different degrees of resistivity and this especially is true in the case of spores, which can be heated to a relatively high temperature without being killed. It has been found, however, that these organisms do not have a wide range of resistance but that a comparatively short exposure is sufficient to kill the most hardy.

For instance, certain spores twenty times as resistant to chemicals as were unprotected forms of germs were destroyed by about three times as much exposure to ultra violet light. In other words, the resistance of these two classes of bacteria is practically the same. The accompanying diagram shows the length of time necessary to efficiently sterilize clear water when inoculated with a variety of germs and spores. *(See Fig. 1, p. 189)*. It has been claimed by some writers that the sterilizing effect of ultra violet light is due to the small amount of hydrogen peroxide which is formed on the exposure of water to the ultra violet rays. Von Recklinghausen states, however, that the amount of peroxide formed is so minute as to be sarcely perceptible even after an exposure of the water for ten or twelve hours. The amount generated during the brief exposure necessary to effectively sterilize with ultra violt light would be not more than about one-fifteen thousandth of the amount which would be necessary to act efficiently as a disinfectant.

Another interesting observation of von Recklinghausen is that while the temperature of the lamp itself has marked influence upon rapidity with which water may be sterilized, on the other hand the temperature of the water itself (provided all turbidity is removed) has very little if any effect upon the rate of sterilization. A perfectly clear and transparent piece of ice, having no bubbles or cloudiness will be sterilized as rapidly as an equal volume of water when exposed to light under the same conditions.

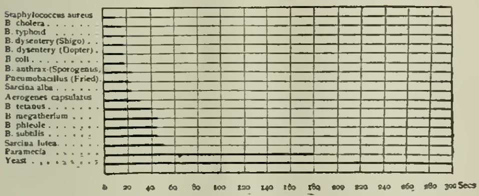
---

[*] All rights of publication in book form reserved by the authors, Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

It is customary in some cases to describe the power of the ultra violet light in candle power, but this method, according to von Recklinghausen, is not a true standard by which to judge a lamp which is to be used for sterilization. The eye is insensible to ultra violet rays and consequently some other method of determining its strength must be devised. Von Recklinghausen states that the only true way of defining these rays would be by the analysis of the spectrum and determining the energy sent out by every wave length in the ultra violet position. This method, however, is very inconvenient. It is not possible in ordinary practice to work with only ultra violet rays. All the rays which come from the lamp must be taken into consideration and their effect noted. According to von Recklinghausen there is no method of sterilization which will cut out all light rays and allow all ultra violet rays to pass. Consequently the working conditions of a lamp are governed by all wave lengths given off. Water is practically as transparent as air to the ultra violet rays, provided there is no coloration or suspended matter which will interfere with the passage of the light rays. It is somewhat difficult, however, to determine when water is entirely free from very finely divided suspended matter which may act as a screen to the light or throw shadows in which bacteria may hide and not become exposed to the action of the rays. In order to eliminate this difficulty, von Recklinghausen suggests that the water be circulated in passing the lamps, in order that all sides of these somewhat small particles may be exposed and sterilization therefore be complete. In the ordinary sterilization of water, however, it is not necessary that the bactericidal content be reduced to zero, it being sufficient to give the light such treatment as will sufficiently remove all pathogenic bacteria. A very short exposure is sufficient to accomplish this result, in case the water is free from suspended particles. Water which is to be sterilized for surgical purposes, however, is treated for a longer period. Von Recklinghausen states that no difficulties are experienced in obtaining water which is sterile enough for surgical operations.

Fig. 1.

Seconds Necessary to Kill Different Types of Germs at 200 mm. from a Quartz Lamp Burning at 66 Volts, 3.5 Amperes.



Inasmuch as the rapidity and efficiency of the operation depends to a large extent upon the transparency of the liquid to be sterilized one would expect great difficulties in the sterilization of opaque substances such as milk. Von Recklinghausen states that many attempts have been made to sterilize milk, some of which were only partially successful due to the thickness of the layers exposed. He further states, however, that it is perfectly feasible to cause excellent sterilization of these bodies in case they are spread out thin enough and the milk is treated when fresh. The reason for the milk being more readily sterilized when fresh is due to the fact that young colonies of microbes or bacteria are more readily destroyed than older ones. Thus, as the milk stands, the bacteria colonies become older and consequently more resistant to the effects of the ultra violet light. It is also of interest to note that not only are bacteria destroyed by the action of the ultra violet rays, but according to von Recklinghausen, toxins are destroyed rapidly. The value of the ultra violet light in therapeutically treating certain diseases, such as tuberculosis, is considered by von Recklinghausen to be due to the fact that as the blood flows near the surface it is exposed to the action of the light rays and the toxins are killed. Thus, by giving long enough exposure it would be expected that a large portion of the blood would pass the blood vessels close to the skin and be purified.

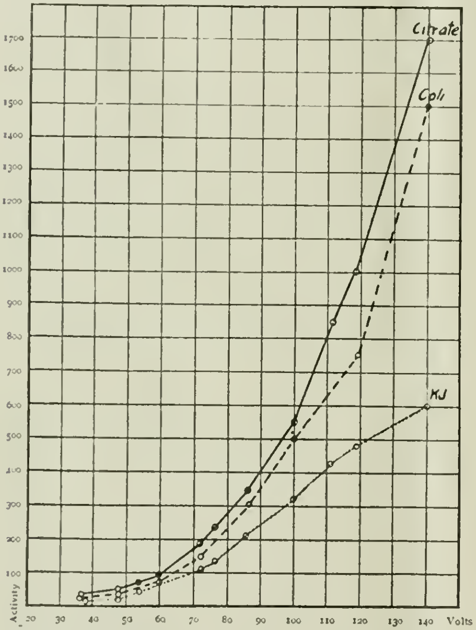
As the amount of ultra violet rays given out by a mercury vapor lamp depends to a greater or less extent upon the temperature at which the lamp is working, it is advisable in the sterilization of water, not to allow the water to touch the tube itself, as this would lower the temperature and therefore cut down the production of the short wave lengths. Von Recklinghausen observes that a physically perfect water will require very little illumination for complete sterilization, but due to the fact that it is almost impossible to commercially procure a water which is physically perfect, it is desirable, according to von Recklinghausen, to give the water several exposures, either by letting it pass the same lamp two or three times by a series of operations or by running it past several lamps. A rough and ready way of determining whether a water is sufficiently clear for rapid sterilization may be carried out by observing the sample under a strong light, against a dark background, when particles which are large enough to obstruct the light waves or hide bacteria will be revealed. (*See Fig.* 2)

In the Journal of the New England Water Works Association, 1914, 202, von Recklinghausen discusses the conditions under which water is best sterilized by ultra violet rays. The water should be free from suspended particles which cast a shadow, in which the bacteria would be shielded from the action of the rays. Coloring matter in small quantities and a small amount of colloidal material are stated by him not to be a serious drawback to sterilization, especially if the water be agitated when passing the lamps. Ice, if hard and clear, does not interfere. The lamp should be run at such a voltage as to maintain a temperature of about

700°C., when it will emit light which is rich in short rays. The lamp should be spaced away from the water so that the latter will not have a cooling effect on the lamp. The type of lamp known as the pistol lamp is the most efficient, about 90 per cent. of the rays being effective. Experiments show that 99.97 per cent. of the bacteria have been killed in filtered water by the action of the ultra violet rays and it is probable that the remaining .03 per cent. escaped because they were protected by floating particles in the water. About 100 kilowatt hours of current are required to sterilize a million gallons of water. As it is impossible to overdose water when sterilizing by this method a large factor of safety may be used. This is not possible when chemicals are used, otherwise the water will have a bad flavor. With current at one-tenth cent per kilowatt hour, the cost of sterilizing water is stated to run from ten to thirty cents per million gallons including upkeep of lamps.

Fig. 2.

Comparative measure of ultra violet activity of 220 volt quartz lamp burning at different voltages by three methods: (a) Decomposition of citrate of silver; (b) decomposition of potassium iodide; (c) annihilation of bacterium coli.



Cost of Operation.

Von Recklinghausen (Elec. World, 62, 181) further states that water can be economically sterilized by ultra violet rays, if it is free from suspended matter. A large quartz tube mercury vapor lamp for this use has been developed. The tube is made of the pistol type; the ends being held in a clamp and the whole tube pushed into a quartz cylinder which projects into the chamber containing the water to be sterilized. This allows practically all the rays from the lamp to enter the water. The largest type of these lamps in service is used on a 500-volt circuit, taking about 3 amperes and 375 volts. The ultra violet production of these lamps is almost 50 times as great as that of an ordinary 110-volt, 3.5 ampere lamp. (Power ratio = 4:1). This result is probably due to the mutual heating effect of the two branches of the tube. For sterilizing 500—2000 tons of water per 24 hours, 1 or 2 lamps are required. For more water, a multiple unit is used, i.e. several lamps in a canal through which the water flows. Such a canal has been in continuous operation in a municipal water plant in Europe for 8 months, treating 7,500—8,000 tons of filtered river water per day. The apparatus is very simple and requires scarcely any attendance.

Efficiency of Ultra Violet Light Compared With Ozone.

Von Recklinghausen notes that (Proc. Am. Inst. Elec. Eng. 33, 1906, 1914; Chem. Abs. 1915, 494) the inverse square law holds true in the case of ultra violet rays used for sterilization if correction is made for the line shape of the source and for some absorption in the air. Water as it comes from a mechanical filter may be treated at a total cost of $0.60 per million gallons. While chemical treatment may be somewhat cheaper, considering the expert attention required, any increased cost would be offset by a cleaner, chemical-free water. Typhoid records from certain European towns show a total absence of this disease since ultra violet sterilization was introduced. Regarding competition with ozone, a comparative test run at Genoa for six months showed an equal cost for power, but a higher first cost and operation cost for the ozone equipment.

Effect of Agitation.

Another process for sterilizing liquids disclosed by von Recklinghausen, (J. S. C. I., 1915, 1223; U. S. Patent 1,156,947, October 19, 1915) involves an apparatus by means of which water or other liquid to be sterilized flows in comparatively thin films past the lamp and at certain different points, this effect being obtained by placing within the treating vessel a number of baffle plates and forcing the water to pass over one baffle and under the next and so on. By this method the water is passed by the lamp any desired number of times, as well as being agitated, which allows the action of the rays to become effective in liquids containing small particles in suspension because of the fact that these small particles are rotated and light strikes all sides of them.

Mineral Deposits on Lamp.

Henri, Helbronner and *von Recklinghausen* (U. S. Patent 1,200,940, Oct. 19, 1910) state that when water is being sterilized, deposits of mineral matter similar to boiler crust, form on the lamp tube, thereby interfering with the passage of the ultra violet rays. In order to obviate this, they propose to construct an apparatus in which the water circulates around the protecting tube of the lamp, thereby keeping it clean. Another advantage of this apparatus is that the water is agitated in its passage and is brought in close contact with the lamp, causing effective sterilization.

Sterilization of Opaque Liquids.

In another process for treating liquids with ultra violet light, Henri, Helbronner and von Recklinghausen, (U. S. Patent 1,140,818, May 25, 1915) state that in sterilizing opaque or highly colored liquids such as milk, wine and so forth, it is undesirable to have the liquids exposed to the atmposhere while undergoing the sterilization process. In apparatus which they describe, the liquid to be treated is passed through a shallow chamber which is provided with a cover of some substance such as quartz which is transparent to ultra violet rays. The lamp is placed in such a manner that the rays may reach all parts of the container and thus become efficient for the treatment of the liquid contained in the chamber. In one instance the treating chamber is circular in cross section, the liquids to be treated being allowed to flow along the sides in a thin film. Provision is also made for cooling the apparatus.

The Investigations of Parkinson.

Parkinson (Thirty-third Annual Report of Provincial Board of Health of Ontario, Canada, 1914, page 156) has made a thorough research on the sterilization of water by means of ultra violet light.

The source of water used by Parkinson is the Great Lakes, which he states is very satisfactory for use during the greater part of the year but in case of storms the water becomes turbid and is quite highly infected. Purification by filtration and chemical treatment therefore becomes necessary in order to insure at all times a pure drinking water. Owing to the purity of the water as it came from the purification plants it was necessary for Parkinson to pollute the water in order to have the bacteria count high enough for accurate results. Two types of apparatus were used by Parkinson, one being a small form having a 110-volt lamp, the other a larger apparatus having a 500-volt lamp In both cases the apparatus was of the gravity type. In the smaller apparatus the lamp was suspended over the water, while in the larger one the lamp was entirely surrounded by the water during sterilization. Both pieces of apparatus were supplied with baffles, which were movable so that they could be shifted from one place to another or be removed entirely. After a long series of experiments with the baffles in various places and removed altogther, Parkinson concludes that baffles are not necessarily in apparatus for the sterilization of water and that sterilization takes place almost immediately when the water comes in contact with the rays from the lamp. He states, however, that by using baffles a safety factor is obtained which makes sterilization a little more sure. When using ultra violet light for the sterilization of water, it is impossible to impart an undesirable flavor to the water by over-treatment, consequently the only drawback to long treatment is the additional expense. In the location of apparatus for treating water Parkinson states that he had some difficulty from dust being deposited around the lamp, which caused its efficiency to be decreased. In order to obviate this, the sterilizing apparatus should be placed in some locality which is as free from dust as possible and it may prove advantageous to enclose the apparatus entirely in some special form of housing. In regard to the effect of slight turbidity on the sterilization of water, when treated with ultra violet light, Parkinson concludes that a small amount of turbidity is not detrimental, but in case turbidity is present the treatment with light must be slightly prolonged and the water should be agitated. Gross particles, however, should be avoided, inasmuch as they serve as a hindrance to the penetration of the light and perhaps throw shadows in which the bacteria are shielded from the light rays. When treating water with ultra violet rays, Parkinson states that one noticeable feature is that the quality of the water so sterilized is very constant. There are no jumps of the bacteria count and in case the sterilizing apparatus is working steadily the bacteria count should remain practically constant, provided of course, the operating conditions, such as flow of water, voltage of lamp, etc., are maintained constant. Various tables are given in which the details of various experiments are collected, and conclusions are drawn from these tables.

TABLE I.

Adjustment of Baffles.

Date.	Horizontal Baffles.	Opening in the Inclined Baffles.	Turbidity. Parts per Million	Voltage.	Percentage Bacterial Removal. 18-22° C. Count.	37.5° C. Count.
Dec. 24	In place	¼ inch	1	350	99.84	98.7
Dec. 24	In place	½ inch	1	350	99.3	99.2
Dec. 24	In place	1 inch	1	350	99.8	99.67
Dec. 24	In place	1½ inch	1	350	99.8	99.7
Dec. 24	In place	2½ inch	1	350	99.84	99.72
Dec. 26	Removed	¼ inch	30	350	97.5	98.5
Dec. 26	Removed	½ inch	20	350	97.5	98.4
Dec. 26	Removed	¾ inch	1	350	99.6	99.9
Dec. 26	Removed	1 inch	20	350	98.7	99.0
Dec. 26	Removed	1½ inch	30	350	98.5	98.6
Dec. 26	Removed	2 inch	20	350	99.4	99.4

The following data from Parkinson's report illustrate concisely his conclusions in regard to several points which apparently are not definitely settled in the minds of various investigators:

Table 1 illustrates the effect of the baffling system on the sterilizing apparatus used, together with the results obtained on removing the baffles. It will be noted from this table that there is no great variation in the bacteria content when using the greatest baffling effect possible and also the least with the apparatus at hand, although there is a high bacteria count at the intermediate stage which is probably due to some outside source.

TABLE 2.

Progress of Sterilization in "D. F." Tank.

Sample Point.	Average Bacterial Count 18-22° C. Count.	Average Bacterial Count 37.5° C. Count.	Average Bacterial Count *Colon Fermentation.	Percentage Removal 18-22° C. Count.	Percentage Removal 37.5° C. Count.	Percentage Removal Colon Fermentation.	Percentage Removal Average Removal.
Influent	730	200	1,230				
A	50	17.4	31	93.2	91.3	97.5	94.0
B	49.5	12.7	29	93.4	93.6	97.6	94.8
C	23	4.2	29	96.9	96.9	97.6	98.1
Effluent	26	16.4	20	96.4	96.8	98.4	97.2

*B. coli per 100 cc. presumptive tests.

In Table 2 Parkinson gives the results of data of an instructive character as to the length of time necessary to cause sterilization. The samples taken at the various points are as follows:

A indicates a point just below the first baffle. B indicates a sample taken about midway between a set of baffles. C indicates a point close to the lamp just before the water passes out into the overflow. It will be noted from this table that there is almost complete bacterial removal when the water first comes in contact with the light.

TABLE 3.

Effect of Turbidity on the Rate of Sterilization.

Rate of Flow in Gallons per Hour.	Number of Samples.	Turbidity Parts per Million.	Voltage.	Percentage Bacterial Removal 18-22° C. Count.	Percentage Bacterial Removal 37.5° C. Count.	Percentage Bacterial Removal Colon Fermentation.
3,000	40	under 1	350	99.81	99.82	99.88
	20	30	350	99.4	98.5	
5,000	65	under 1	350	97	94	97.4
5,000	20	40	350	94.9	91.3	99.46
5,000	20	under 1	325	87.5	75	96.3
7,000	74	under 1	350	86.8	94.4	96.0
7,000	20	10	350	91.8	86.4	97

Table 3 shows the results of Parkinson's experiments upon the effect of turbidity, within certain limits, on the rate of sterilization. A large number of samples were used in each instance and conditions as to flow and voltage of lamp kept as near constant as possible. It will be noted from this table that there is practically no difference in the bacteria count at a given slow rate of speed in the turbid water and in that which is practically clear. Where high velocities were used, however, it will be noted that there is a difference in the bacteria count, depending upon the increase in turbidity and the increase in rate of flow, but a greater variation than this is caused by a change in the voltage of the lamp.

The details of the method of operating the lamp, of taking the bacteria count and of adding the definite contamination to the water supply are given in full.

Effect of Cooling Lamp Electrodes.

Thompson, (English Pat. 28,757, December 20, 1911) states that for the purpose of sterilizing water and other liquids it is preferable to keep the vapor pressure in the mercury lamp employed as low as possible; hence the electrode-containing cells must be efficiently cooled. On the other hand in order to avoid undesirable contact between the quartz globe of the lamp and the liquid, a quartz jacket is employed and the interspace is exhausted. In the lamp described, the quartz jacket does not extend to the electrode-containing cells at the end of the lamp, but is connected to the illuminating tube between the cells. The electrodes are thus kept cool by the liquid being sterilized or in case this is warm, by some external means, thus keeping the vapor pressure of the mercury low.

Effect of Peaty Waters.

Grimm and *Weldert* (Mitt. K. Pruf. Anst. f. Wasserversorg. u. Abwasserveseit. 1911, 14, 85; Chem. Zentr. 1911, 1, 1454) experimented with a mercury vapor lamp of 1,200 candle power and closed in a double walled quartz vessel, through which water was passed. Clear water containing less than 100 bacteria per cubic centimeter could be sterilized when passed through the apparatus at a velocity of 0.55 cubic meters per hour, but with water very rich in bacteria, sterilization was effected only when the velocity did not exceed 0.45 cubic meters per hour. Turbidity and the yellow coloration due to colloids, such as is observed in peaty waters, destroy the efficiency of the treatment for practical purposes. The cost of the treatment is stated to be very high compared with that of existing processes.

Swimming Pools.

The water of swimming pools can be purified by being passed rapidly through a filter and then subjected to the action of the ultra violet light (Scientific American, Aug. 15, 1914, 120). Tests have shown that all bacteria of intestinal origin are destroyed and the same water may be used over and over for weeks or even months.

U. S. Public Health Report.

A result of a study of the conditions on steam vessels engaged in interstate commerce in the sanitary district of the Great Lakes, is reported by *Cobb, Williams* and *Letton* (U. S. Pub. Health Rept. 31, 2845-67). The types of purification apparatus in use on the vessels of the Great Lakes are at present inefficient in maintaining the standards of purity prescribed by the U. S. Treasury Department. Three methods of purification are recommended; automatically operated water stills; injection of steam during the pumping of the water; and the use of ultra violet sterilizers. There is no other method recognized that under all circumstances will produce a water meeting the Government requirements.

The Oscillating Spark.

Kowalski (Elec. Rev. West. Elec. 66, 1055-6, 1915) states that the oscillating spark was found to be a more economical source of ultra violet light than the quartz enclosed mercury vapor lamp. Water sterilization requires but 45-90 watt hours per 1,000 gallons. To increase the amplitude, the capacity of the oscillating circuit must be as great and the inductions as small as possible. Electrode material and frequency of sparking determine the ultra violet radiation. The intensity from a 22 millimeter gap between invar electrodes is proportional to 2, 1.6, 1.3 and 1.0 with 20, 30, 40 and 50 sparks per second. The percentage distribution of radiation horizontally in the direction of the axis of a 110-volt Heraeus lamp at 90 volts and 3.1 amperes was: heat 24%, visible rays 41%, ultra violet rays 35%. From 22 millimeter gap between invar electrodes at 30 sparks per second with 50.5 amperes in oscillating circuit: heat 22%, visible rays 18.6, ultra violet 59.4%. Oscillating sparks show 70% greater ultra violet radiation. For water sterilization the spark may be produced directly in water without a quartz envelope, which means an additional saving.

Effect of Colloids.

Courmont (Chem. Zeit., 1911, 35, 806; J.S.C.I., 1911, 1027) discusses the remarkable sterilizing power of the ultra violet light from a quartz mercury vapor lamp. For sterilizing water, which is comparatively transparent to the radiation, it is sufficient to place the lamp in the axis of a cylindrical vessel 60 cm. in diameter. Liquids containing colloids (wine, beer, peptone solution, etc.) absorb the ultra violet rays rapidly, and therefore sterilization is limited to the surface layer. For greatest efficiency, therefore, the water to be sterilized should be as clear as possible. Courmont also states that the action of sterilization is in no way connected with ozone or hydrogen peroxide formation.

Although malt liquors cannot well be sterilized by means of the mercury lamp, according to *Rolle*, (Woch. Brau, 1911, 28, 533, J.S.C.I., 1911, 1330), owing to their opacity to ultra violet rays, clear water can be completely sterilized almost instantaneously. *Rogier* has devised an apparatus for this purpose, which can be fitted to a water tap. It consists of a cylindrical mercury lamp, 30 cm. long, enclosed in quartz, and fixed in the axis of an aluminum tube 10 cm. wide, constructed near one end so that the water, in passing through, is brought very close to the lamp. The apparatus requires a current of 6 amperes at 30 volts, and is stated to produce per hour, 1,000-1,500 litres (200-300 gals.) of absolutely sterile water which can be used for drinking with perfect safety. A plant installed at Marseilles for sterilizing the drinking water by ultra violet rays, requires an expenditure of 12,000 kilowatt hours per 100,000 cubic metres (220,000,000 gals.) at a cost of 0.24d. per cubic metre (1.1d. per 1,000 gals.). A large waterworks with its own electric plant could, however, reduce this cost to 0.45d per 1,000 gals., which is cheaper than sterilization by means of ozone and the apparatus required is much simpler and less costly.

Effect of Air Bubbles.

Von Recklinghausen (J.S.C.I., 1915, 1223; U. S. patent 1,156,948, October 19, 1915) claims that aside from particles in suspension, which cause turbidity, the greatest source of incomplete sterilization is caused by minute air bubles which throw shadows of sufficient density to shield the bacteria from the ultra violet rays. In apparatus described by von Recklinghausen it is claimed that this effect is practically overcome by forcing the water through a chamber in which there is a straight or unimpeded path, thereby avoiding the formation of air bubbles.

Emulsions Containing Bacteria.

Cernovodeanu and *Henri* (Comptes. rend., 1910, 150, 52) have tested the action of the ultra violet rays emitted by mercury lamps, on a variety of bacteria in emulsions containing from 10,000 to 100,000 per cubic centimeter. The bactericidal action of the ultra violet rays decreased more quickly than the square of the distance of the source from the bacteria. A 220-volt Cooper Hewitt lamp is five times as active as a 100-volt lamp when close to the bacteria and relatively far more active when further away. The bactericidal action is slightly greater when the layer of emulsion is thicker. Variations in temperature from 0° to 55°C. have no effect, and destruction of the bacteria is as rapid in the absence of oxygen as in the air. An emulsion made with water previously exposed to the rays is not more sensitive and the bactericidal action is not accelerated by the presence of traces of hydrogen peroxide. Different species of bacteria vary in their resistive power; whereas bacillus coli is killed in 15-20 seconds, bacillus subtilis requires 30-60 seconds . The most destructive of the ultra violet rays are those possessing a wave length above 2,800 Angstrom units. Protoplasm absorbs ultra violet rays of wave length above 2,900; accordingly it is the rays absorbed by the cell protoplasm which have the bactericidal action.

Sterilization of Milk.

Bloxham and *Ahrndsen* (Eng. Pat. 12,333, May 22, 1911) have proposed the following process of sterilization. The liquid, such as milk, is frozen into blocks or plates which are then exposed to the action of ultra violet rays. As the blocks thaw, a thin film of liquid is formed which is sufficiently transparent to enable it to be sterilized thoroughly by the rays.

Ayers and *Johnson* (Centr. Bakt. Parasitenk, Abt. II, 40, 109-13, 1914) have shown that ultra violet rays may markedly reduce the bacterial content of milk, but that they have no effect on vegetative cells. This method of sterilizing milk could not replace pasteurization because there would be no assurance of the destruction of pathogenic bacteria. Ultra violet rays impart to milk a disagreeable odor and taste which would render it unsalable.

Helbronner and von Recklinghausen, (U. S. patent 1,141,056, May 25, 1915) in sterilizing certain opaque liquids such as milk, in which it is necessary for efficient treatment that very thin films be obtained, note that complete sterilization by means of ultra violet light alone is quite difficult and that the prolonged treatment necessary is quite likely to have deleterious effects upon the flavor and digestive qualities of the liquid. They therefore propose to use a combination of heat sterilization together with ultra violet light. It is stated that when milk is given a short heat treatment at a temperature above 60° Centigrade, the bacteria therein become so weakened that they are readily destroyed by ultra violet rays. It is claimed that by this combination treatment the milk is not given a heat treatment sufficient to materially alter the flavor and that a very short exposure to the ultra violet light is sufficient to completely sterilize the liquid.

Walker (British patent 16,110, July 12, 1911) sterilizes milk, beer, water or other liquids by allowing the liquid to flow from perforated distributing pipes over inclined quartz plates and thence downwards over the surface of two or more corrugated metal plates. These plates are arranged around a mercury vapor lamp and the liquid is collected in a trough placed below the lower edges of the plates.

Sterilization of Fats.

Fats, butter and the like are sterilized by means of ultra violet rays according to Soc. Le Ferment (French Pat. 400,921, Mar. 17, 1909) in the following manner: The fat is spread in a thin layer on the surface of an endless band or on a drum. The movement of the band carries the layer of fat past a number of lamps which emit ultra violet rays. These lamps are provided with a reflector. The fat is removed from the band by means of a scraper after it has passed the lamps. The band may be heated or cooled as desired.

Sterilizing Barrels.

From his experiments, *Moufang*, (Kirm. a. d. Nahe Allgem. Z. Bierbrau. Malzfab. 43, 151-5, 1915) concludes that by the application of ultra violet rays for sterilizing barrels (by means of a specially constructed quartz lamp which could be inserted through the bung hole) the biological condition of pitched barrels may be greatly improved, but that perfect sterilization in a biological sense is not obtained by the present appliances.

Relative Germicidal Properties of the Rays.

In a discussion of ultra violet rays and their practical applications, *Berthelot* (Soc. Ing. Civil de France, Proces-Verbal, 1911, No. 15, 147) divides ultra violet rays into four classes as follows: (1) Solar ultra violet rays (wave length = $0.4\text{-}0.3\,\mu$), comprising those ultra violet rays which reach the surface of the earth from the sun. These rays have not a destructive action on organisms, but act chemically and physiologically in a manner not greatly differing from that of the violet and blue rays of the visible spectrum. (2) Medium ultra violet rays (wave length = $0.3\text{-}0.2\,\mu$). These rays exert a germicidal action, while chemically they play a similar part of many enzymes and catalyzers in effecting decomposition. They produce numerous chemical reactions, mostly of an exothermic irreversible character. Such rays are used on a large scale for bleaching olive oil. (3) Extreme known ultra violet rays (wave length = $0.2\text{-}0.15\,\mu$) which possess similar germicidal properties to the rays of the preceding class, but chemically they act synthetically, producing reversible reactions of an endothermic character. With the aid of these rays it has been found possible to effect synthesis of carbohydrates, and of formamide, which may be regarded as the prototype of proteins. (4) Unknown ultra violet rays (wave length = $0.15\text{-}0.1\,\mu$). Only the existence of these rays is known, but nothing as to their properties, for they are absorbed by all substances, even by the thinnest film of gas. The rays belonging to classes (2) and (3) are produced for technical purposes by arc lamps and by quartz mercury vapor lamps. These rays are used in medicine for the treatment of skin diseases and for destroying pathogenic organisms. They are also being used extensively for the sterilization of water and for similar purposes.

Manner of Destruction of Living Cells.

The mode of action of ultra violet radiation in producing sterilization is discussed by *Burge* (Journal of the Franklin Institute, 264, 1916). Since the life of a living cell is dependent upon its intracellular enzymes, and since the ultra violet radiation destroys enzymes, a theory has been advanced that ultra violet radiation kills living cells by destroying the enzymes of the cell. In an investigation of this theory pure cultures of B. prodigiosus, B. fluorsceens, B. liquefaciens, were chosen because they possess the property of liquefying gelatine, this property in turn being dependent upon the intracellular proteolytic enzymes. Twenty-five cubic centimeters of liquid containing great numbers of B. prodigiosus were exposed in an open vessel to the radiation from a quartz-mercury vapor burner operating at 140 volts, 3.3 amperes, at a distance of 10 centimeters until the bacteria were dead. The dead bacteria were thrown down by means of a centrifugal and washed in physiological saline. The mass of dead bacteria was ground up in a mortar with sand and 30 per cent. alcohol, thus extracting the intracellular enzymes from the dead bacteria. All of the bacteria named above were treated after this manner. Ten cubic centimeters of the alcoholic extract of the different kinds of dead bacteria were introduced into separate test-tubes containing gelatine. Ten cubic centimeters of liquid containing the different kinds of living bacteria were also introduced into tubes containing gelatine. These tubes were permitted to stand at room temperature for 96 hours. At the end of this time the extent to which the gelatine had been liquefied in the different tubes was measured. The extract of dead B. prodigiosus had liquefield 7 mm. of gelatine; B. fluorescens, 6 mm.; B. liquefaciens, 10 mm.; B. pyocyaneus, 4 mm.; N. proteus vulgaris, 5 mm., and B. subtilis, 4 mm. If the amount of gelatine liquefied by the living bacteria be compared with that liquefied by the extract of the corresponding dead bacteria, it will be found that there is very little difference in the extent of liquefaction. It is therefore assumed that while the ultra violet rays had killed the bacteria, it had only slight effect on their intracellular enzymes.

Henri (Compt. rend. soc. biol., 73, 323) has found that the destructive action of ultra violet rays toward the life of organisms is almost exactly proportional to the coefficient of extinction of protoplasm; this proportionality indicates that the action of ultra violet rays on micro-organisms follows the law of photochemical absorption which has been found for the majority of photochemical reactions, and also that the mechanism of the action of ultra violet rays consists in a direct reaction on the cellular content and not in an indirect action, such as the formation of hydrogen peroxide, etc. The rays of greatest destructive power penetrate only a few thousandths of a millimeter into the interior of organisms and it is only for extremely small organisms that the action of these rays is analogous to a simple photochemical reaction. The velocity of the reaction produced in hydrogen peroxide or an acid solution of potassium iodide is greater (for a given intensity of irradiation) for discontinuous than for continuous irradiation; this difference is due to processes of diffusion which take place during the periods free from irradiation. In the case of bacteria there is no difference between continuous and discontinuous irradiation. With larger organisms the effect of continuous is greater than of discontinuous irradiation in spite of the diffusion processes concerned, this difference being probably due to processes of reparation in the organism which play the part of reversible reactions, the general effect being comparable to a complex photochemical reaction.

Burge and *Neill* (Am. J. Physiol. 38, 399-403, 1915) have found that fluorescent bacteria (non-spore formers) are much more resistant to ultra violet light than non-fluorescent organisms. It is assumed that fluorescent bacteria are able to convert the short wave lengths into longer wave lengths and thus escape their protein-coagulating power.

Bazzoni (Am. J. Pub. Health 4, 975-92, 1914) states that the full radiation from certain sources of light containing waves below 250 in length, will kill bacteria. Isolated ultra violet rays (250-280) will not affect bacteria in one drop of water in an hour exposure. Isolated ultra violet rays as short as 220-225 will kill only after several hours, even when the isolated radiation is of the same intensity as that contained in the rapidly destructive full radiation. The destructive power increased with the decrease in wave length. The destructive action of ultra violet light is therefore considered by Bazzoni to be probably dependent on its association with longer radiations.

The mycoplasma of bacteria, according to *Stoklasa* (Lentr. Biochem. Biophys. 18, 370) are very sensitive toward ultra violet rays. Azotobacterium was killed by the rays within 8-10 seconds at a distance of 10 centimeters.

Vallet (Comptes. Rend., 1910, 150, 632) has studied the action of ultra violet rays, generated in a quartz mercury lamp, on various solutions containing Bacillus coli communis. It is found that liquids such as ethyl alcohol, glycerol and certain saline solutions, are easily traversed by the rays, but albumin, peptone and oil for example, are strongly opaque. Moreover, compounds like the latter seem to be additive in their effect, for solutions containing amounts of them which separately would not be sufficient to stop the rays, no longer allow them to pass when present together.

(To be continued in the August issue.)

PLATINUM CONSUMPTION OF THE UNITED STATES

In the article on Platinum Deposits of the World, prepared by the Geological Survey and published in Commerce Reports for April 23, the statement was made that the United States alone apparently uses about 65,000 ounces of fine platinum a year. The Geological Survey has corrected this statement as follows: Domestic refiners produce 65,000 ounces of fine platinum annually from the United States. The total quantity of refined platinum used each year in the United States is about 165,000 ounces, imports contributing 100,000 ounces.

Iodine, Iodoform, Anaesthetics, Etc.

Lambert-Georgin Chemicals Corporation, Manhattan, has been incorporated under the laws of New York, with a capital of $100,000, to manufacture products of soda, and iodine, iodoform and various anaesthetics. The incorporators are F. Kriegel, M. Hotchner and L. F. Corca, 56 Pine Street, New York City.

THE CHEMICAL ENGINEER

VOL. XXV. JULY, 1917 No. 5

Published Monthly by the

McCready Publishing Company.

ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, JULY, 1917

Coal-Tar Chemistry 161
Edited by Thomas H. Norton, Ph.D., Sc. D.
Under which is included:

I—EDITORIALS:

After the War—What of the Export Trade in Chemicals? 161
The Necessity for an Early Standardization of Color Concentrations and Values.......... 165
H. Gardner McKerrow.
Eastern States Exposition.................. 166
The Merger of Leading American Manufacturers of Coal-Tar Crudes, Intermediates and Colors 167

II—COAL-TAR CRUDES:

The Estimation of Toluene in Crude Petroleum 168
The "Cracking" of Solvent Naphtha.......... 168
Improvements in Tar Distillation............ 169
New Form of Naphthalene for Use as an Insecticide 169

III—COAL-TAR INTERMEDIATES:

Remarkable Explosion in an Aniline Plant.... 169
New Method for the Preparation of Crude Sodium Salicylate 170
The Evolution of Trinitro-Toluene.......... 170
Recovery of Picric Acid from Wash Water.... 171
Separation of Aromatic Sulfonic Acids from Sulfuric Acid and Their Technical Preparation in a Solid Form.................... 171
B-Naphthol Derivatives for Disinfection Purposes 172
Diseases Incident to the Manufacture of High Explosives 172
Analytical Studies on Coal-Tar Compounds.. 173
Theoretical Studies on Coal-Tar Compounds.. 173
Toxicity of Benzene Derivatives to Insects.....174
Determination of Carbolic and Salicylic Acids in Antiseptic Gauze and Cotton............ 174
The Manufacture of Dimethyl-aniline, Monomethyl-aniline, Diphenylamine and Their Homologs 174

IV—ARTIFICIAL COLORS:

The Examination of Food Coloring Substances 175
New Azo Insoluble Dye.................... 175
Artificial Dyestuffs as Antiseptics........... 175
New Dyestuffs from 2.5.7-Amino-Naphthol-Sulfonic Acid 175
Artificial Dyes in Forensic Analysis and Microscopic Technique 175
Proposes Modification in the Tariff on Artificial Colors 176
The Use of Coal-Tar Dyes on Leather........ 176
Dyestuffs for Leather....................... 176
Papers on Dyeing 177
Methylene Blue as a Reagent in Chemical Analysis 177
Rapid Method for Comparing the Decolorizing Efficiency of Charcoals 177
New Black Sulfur Dyes.................... 177
New Lakes in the Dihydro-Anthraquinone Series 177

V—NATURAL DYES:

A New Dyeing Machine.................... 177
Dyestuffs from Yacca Gum and Congo Resin.. 177

VI—SYNTHETIC DRUGS AND PERFUMES: PHOTOGRAPHIC DEVELOPERS:

Death of Alois Von Isakovics............... 178
Salvarsan 178
Sodium Phenetidino-Methane-Sulfonate...... 178
Limited Use of Saccharin Now Permissible in France 178
Current Production of Synthetic Perfumes.... 178
Analysis of Synthetic Drugs 178

VII—BOOK REVIEWS:

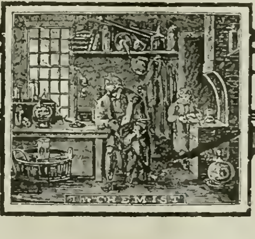
"Notes on Military Explosives"............ 179
"How to Build Up Furnace Efficiency"...... 179

VIII—CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS:

Crudes, Intermediates, and Explosives........ 179
Synthetic Medicinals, Flavors and Perfumes; Photographic Developers, Artificial Colors, Natural Dyestuffs, Dyewoods and Raw Materials, Extracts, Dyeing Accessories.... 180
Determination of the Explosibility of Pyrites.... 181
C. R. Gyzander.
Program for Third Chemical Exposition Nearing Completion 187
A New Process for the Manufacture of Phthalic Acid and Its Anhydride 187
Ultra Violet Light: Its Application in Chemical Arts. Part V....................... 188
Carleton Ellis and A. A. Wells.
Platinum Consumption of the United States.... 195
Table of Contents.......................... 196
Chemical Investigation, Efficiency and Control.. 197
Conducted by Charles B. Davis.
Distillates: News Notes of Chemical and Allied Industries 198
Foreign Trade Opportunities................. 199
July Prices of Chemicals.................... 200

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.



ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

J. P. G. You are correct; there are many cases where the melting points of euteactic mixtures change. I have received the samples from your "works control" laboratory, for the checking of the various determinations and will report the results to you, at the earliest possible moment.

R. J. T.—Of the total humic substance (4 to 5%) present in maple leaves, about 2% becomes water soluble and suitable for fertilizer after four days of decomposition. During decomposition this solubility in water at first increases and then decreases until after 156 days it disappears completely.

R. T. S.—For spray irrigation the capacity of a pump usually is stated in gallons of water per minute of time. The following data of equivalents will, I am sure, assist you in converting local irrigation units into gallons and acre-inches for the estimating purposes:

1 acre-inch equals 27.152 U. S. gallons.

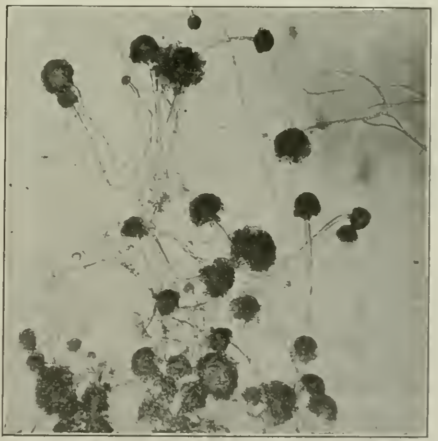
1 acre-inch equals 3.630 cubic feet.

1 acre-inch per hour equals 452.50 gallons per minute.

1 acre-inch per hour equals 1.009 cubic feet per second.

S. P.—The only superiority Saccharin Benzoylsulphonic Imide, $C_7H_5NO_3S$, or $C_6H_4(CO)SO_2NH$, has over cane sugar is its enormous sweetening power in a very small bulk, being 550 times the sweetness of sugar, and still detected in dilutions of 1 in 70,000 parts of water. It possesses absolutely no food value, is non-fermentable, and in anything but extremely small doses is injurious to the health. It is a coal tar manufactured product, and aside from its intensified sweetness and antiseptic qualities it has little or no value.

M. B.—I am in receipt of your peach pulp, and find it badly contaminated with eurotium aspergillus glaucus, which is a mould growth containing a sugar splitting enzym and a species of aspergillus oryzae. Its microscopical appearance (see microphotograph) is branched mycelium with chains from the ends of which are club-shaped, swollen mycelium threads. I would recommend that your canning plant be subjected to a thorough investigation, and that you supply me with data as to the temperatures you are using, the duration of same, together with samples of the raw and preserved fruits, so that I may ascertain the cause of the contamination.



Charles B. Davis.

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail are specifically requested, communications can only be considered in the order of their receipt.—Editor.

DISTILLATES

News Notes of Chemical and Allied Industries

Addition to Bayway Plant.

The Bayway Chemical Company, Elizabeth, N. J., will erect a subsidiary building at its Bayway plant.

Interstate Chemical Co. Addition.

Plans have been filed by the Interstate Chemical Co., 673 Garfield Avenue, Jersey City, N. J., for an addition to its plant.

Carbo-Hydrogen Co. to Erect Factory.

The Carbo-Hydrogen Company of America, Columbus, Ohio, will erect a factory building on ground recently purchased from the Rood Box Company.

To Increase Bleached Pulp Output.

The paper mill at Petowsky, Mich., will construct an addition to its bleach manufacturing plant which will enable it to take care of the increase in pulp production.

Addition to Jackson Chemical Works.

The recently incorporated Jackson Chemical Works, Irvington, N. J., has filed plans for the erection of a one-story addition to its plant at 487 Chancellor Avenue.

Larger Plant for Seydall Company.

A three-story addition will be made to the chemical plant of the Seydall Manufacturing Company, 88 Forest Street, Jersey City, N. J. The cost will be about $34,000.

New Chemical Plant for Klipstein.

Contracts have been awarded by E. C. Klipstein & Co., Chrome, N. J., for the erection of eight buildings for their proposed new chemical plant at South Charlestown, W. Va.

American Manganese Co. Acquires Steel Plant.

The plant of the Lochiel Steel Company, Harrisburg, Pa., has been acquired by the American Manganese Manufacturing Company, Bullitt Building, Philadelphia, and will be subjected to improvements which will give it an initial capacity of 125 tons of pig iron and 12 tons of ferro-manganese per day.

Filter Press Companies in Merger.

The Kelly Filter Press Company, The Sweetland Filter Press Company and the American Filter Company have consolidated; the new organization is to be known as the United Filters, Inc., with home offices at 321 Felt Building, Salt Lake City, Utah, and eastern offices at 36 Flatbush Avenue Extension, Brooklyn, N. Y.

Mullen Leather Co.

Mullen Leather Co., Boston, Mass., has been incorporated with a capital of $20,000. The incorporators are S. J. Mullen, S. Starsier, Charles H. Poor.

Oils, Colors and Chemicals.

B. Brown & Bro., Inc., New York City, has been incorporated with a capital of $100,000 to manufacture oils, colors, chemicals. The incorporators are J. C. Brown, D. R. Bernstein and L. Sktuch.

New Rahway Chemical Company.

The Rahway Chemical Manufacturing Company, Rahway, has been incorporated under the laws of that state with a capital of $25,000 to manufacture chemicals. I. S. Joseph, G. H. Adler, J. B. Eiseman, Rahway, are the incorporators.

Drugs; Chemicals; Toilet Goods.

Loraine Chemical Works, Inc., Wilmington, Del., has been incorporated with a capital of $75,000 to deal in drugs, chemicals and toilet goods. The incorporators are W. G. Graidstaff, C. E. Tate, R. N. Thomas, C. C. Pitts, E. F. Curtis.

$1,000,000 Chemical Company.

The Advance Coal Company has been chartered in Delaware with a capital of $1,000,000 to manufacture chemicals. The local Wilmington, Del., incorporators are M. L. Rogers, L. A. Irwin and Harry W. Davis.

Drugs and Chemicals.

C. H. Hall, Plainfield, N. J., has been incorporated under the laws of that state with a capital of $25,000 to manufacture and deal in drugs and chemicals. The incorporators are Charles H. Hall, Elizabeth T. Hall and Louis P. Wilson, Plainfield.

Colors and Dyes.

With a capital of $5,000, the Radcliffe Color and Chemical Works, Elizabeth, N. J., has been incorporated under the laws of that state to manufacture and deal in colors and dyes by David D. Radcliffe and John J. Smith, Elizabeth, and John H. Strawbridge, Hillside Township, Union County, N. J.

Petroleum Refinery.

The Transportation Petroleum Company has been incorporated under the laws of Delaware to refine petroleum and distribute its products. The capital is $1,000,000, and the incorporators are F. Fried, G. M. Healy, New York, and Lucian Ross, San Antonio, Texas.

FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Drugs; Dyes; Dyestuffs; Chemicals.

24830—Agencies are desired by a man in England for the sale of drugs, crude and refined, dyestuffs, dyes, chemicals, and all types of allied products. References.

Aluminum Sulphate.

24828—A company in England desires to purchase 10 to 12 tons lots of sulphate of alumina, 17 per cent. to 18 per cent. ground, and free from iron. Quotations should be made c. i. f. Manchester, if possible. Payment will be made by cash against documents in England. References.

Colors and Chemicals.

24809—A company in England wishes to buy chemicals and colors for textile trade, cotton, silk, wool, leather, and paper makers. Samples and complete analysis should be submitted. Payment will be made by cash against documents through New York bankers. Quotations should be made c. i. f. or f. o. b. any port. English weights are preferred. References.

Aniline Dyes.

24829—A firm in French Indo-China wishes to be placed in communication with American manufacturers and exporters of sewing machines, scales, files, nails, sewing needles, sheet zinc, baled newspapers, oil cloth, aniline dyes, corned beef, and canned fruits. Quotations should be made c. i. f. destination, if possible, otherwise f. o. b. American port. Payment will be made by sight draft against documents. Correspondence may be in English. Reference.

Coke.

24808—A foreign trade adviser of a foreign government is in the market for coke suitable for mining and metallurgical establishments. The coke should not contain more than 10 per cent. of ash and moisture content should not exceed 2 per cent. The immediate needs are for 10,000 tons delivered at Cartagena or other Spanish port, 9,000 tons delivered at Tunis, and 6,000 tons at Marseille or St. Nazaire. A change in ports will be allowed. If arrangements can be made at once, contracts can be made for further deliveries in 1918.

Tungsten and Molybdenum Filaments.

24106—A man in Spain desires to purchase filaments of tungsten and molybdenum for the manufacture of electric lamps. He also wishes to entertain an agency proposition. Quotations should be made c. i. f. Vigo or destination. Cash will be paid in New York. Correspondence may be in English. References.

Chemical Products.

24535.—A man in France is in the market for agricultural machinery, watering apparatus, hardware, tools, locks, tin and zinc articles, electrical supplies, heating and lighting apparatus, household furniture, bicycles, rubber wheels, rubber goods, chemical products, and supplies for painting and photography. Catalogues should be submitted.

Soap-Making Materials: Cautic Soda.

24014—An importer in Mexico is desirous of being placed in communication with American manufacturers and exporters of bicycles, motor cycles, automobiles, hardware, corrugated metal plates, tools for mechanics and artisans, paper manufacturers' supplies, and soap-making materials, especially caustic soda.

Chemicals, Chemical Supplies and Machinery.

24513.—A man in France desires to purchase or represent American manufacturers and exporters of all kinds of chemicals, chemical supplies, and machinery for chemical plants. Quotations should be made c. i. f. French port, or f. o. b. American port. Payment will be made by cash against documents if desired. Correspondence may be in English. Reference.

Pharmaceutical and Industrial Chemicals.

24543.—An agency, on a commission basis, is desired by a man in Peru for the sale of small electrical devices, canned goods and foodstuffs in general, paper and paper products of all kinds, chemical products for pharmacies and industries, and small hardware and supplies for trunk, saddle, etc., manufacturers. Quotations should be made c. i. f. destination. Payment will be made by cash against documents at destination. Correspondence may be in English, but Spanish is preferred. References.

JULY PRICES OF CHEMICALS, ETC.

For Prices of Coal-Tar Derivatives See Page 179

Acetone	.32½	.33½
Acid, acetic, 28%	5.02½	—
Acetic, 56%	10.05	—
Acetic, glacial	.40	.50
Boracic, crystals	.13¼	.13½
Boracic, powdered	.13	.13½
Carbolic, cans	.44½	.45
Chromic, tech	1.20	1.25
Chromic, U. S. P.	1.25	1.50
Citric, crystals	.72	.75
Cresylic, 95%	1.10	1.15
Hydrochloric, 18°	1.50	1.75
Hydrochloric, 22°	2.00	2.25
Hydrocyanic, dilute, 3%	.20	.22
Hydrofluoric, 30°	.05	.05½
Hydrofluoric, 52°	.10	.10½
Lactic, pure, 50%	.30	—
Lactic, tech., 50%	.09	—
Nitric, 36°	.06½	.06¾
Nitric, 38°	.06¾	.07
Nitric, 40°	7.36	7.50
Nitric, 42°	.08	—
Oxalic, crystals	.47	.48
Phosphoric, 85%	.33	.37
Phosphoric, 87½%	.33½	.37½
Picric	.75	.85
Pyrogallic, resublimed	3.15	3.25
Pyroligneous, tech., gal	.10½	.13½
Pyroligneous, pure, lb	.05	.05½
Sulphuric, 60°	1.50	1.75
Sulphuric, 66°	1.75	2.00
Sulphurus	.03	.05
Tannic, U. S. P.	1.25	1.30
Tartaric, crystals	.78½	.83
Alcohol, denatured, bbls.	1.00	1.02
Alcohol, grain, 190, U. S. P.	4.02	4.04
Alcohol, wood, 97%	1.05	1.07
Alum, ammonia, powdered	.08½	.08¾
Aluminum sulphate, technical	.02¾	.03
Ammonia aqua, 26°	.06¼	.06½
Arsenic, white	.18¼	.20
Barium chloride	85.00	90.00
Barium sulphate, powder	.04	.04½
Barium nitrate	.12	.13½
Borax, crystals, bags	.07¾	.08
Calcium peroxide	1.50	—
Calcium sulphate	.10	.20
Carbon bisulphide	.06½	.07½
Cobalt, metal, oz.	.32	—
Cobalt, sulphate	—	.50
Copper nitrate	.45	.50
Copper sulphate, powdered	.12½	13
Formaldehyde, bbls	.17	18
Glauber's salt, 100 lbs	.65	.70
Glycerine, C. P., drums	.63	.63½
Iodine, resublimed	3.50	3.55
Iron oxide	.13	.15
Iron sulphide	—	—
Potassium bichromate	.36	.37
Potassium chlorate, crystals	.50	.55
Potassium cyanide, true	2.25	2.50
Potassium permanganate	4.00	4.25
Rochelle salts	.39	.39½
Sal ammoniac, white gran	.14	.15
Soda ash, dense	.04	—
Sodium acetate	.10	.13
Sodium benzoate	4.00	4.25
Sodium bicarbonate	.02	.03½
Sodium chlorate	.24½	.25
Sodium cyanide	.53	.55
Sodium nitrite	.30	.40
Sodium phosphate	.05	.06
Sodium salicylate	.85	.60
Sodium silicate	1.25	1.50
Sodium sulphide	.02	.02½
Sugar of Lead, powder	.17	.18
Sulphur, commercial	3.25	3.50
Sulphur, flour	3.85	4.00
Sulphur, flowers	3.95	4.10
Tin bichloride	.19¼	.19¾
Tin, crystals	.39	.39½
Tin oxide	.64½	.66½
Zinc carbonate	.25	.27
Zinc chloride	.10¼	11½
Zinc oxide	.16	.21
Zinc sulphate	.05½	.06

Essential Oils.

Almond, bitter	14.00	16.00
Amber, rectified	2.25	—
Anise	1.07½	1.10
Cassia, rectified	1.75	1.85
Cedar, leaf	.80	.95
Citronella, drums	.56	.57
Cloves, bottles	2.10	2.20
Eucalyptus, American	.65	.67½
Geranium, Algerian	4.75	4.80
Lemon	1.10	1.20
Limes, expressed	6.00	—
Mustard, artificial	22.00	26.00
Orange, Sicilian	2.85	3.00
Pennyroyal, American	1.65	1.85
Peppermint, cases	3.25	—
Rose, natural	22.00	—
Rose, synthetic	2.75	3.00
Safrol, drums	.40	.45
Sandalwood, E. Indian	11.75	12 50
Sassafras, natural	.75	.80
Thyme, white	1.35	1.50
Wintergreen, leaf	4.15	—

THE CHEMICAL ENGINEER
COAL-TAR CHEMISTRY
Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives
Crudes, Intermediates. Artificial and Natural Colors.
Synthetic Medicinals, Flavors and Perfumes. Explosives,
Photographic Developers.
Edited by
THOMAS H. NORTON, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

Sidney Blumenthal, President, "The Shelton Looms," Shelton, Conn.

George H. Bruce, LL.B., Gold Leaf Manufacturing Co., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hebden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles.

H. Gardner McKerrow, of the Marden, Orth and Hastings Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

EDITORIALS

The Organization of National Industrial Research

There is no question but that the chief occasion for Germany's marvelous powers of offense and defense in the present world struggle, and for her dominating position in the manufacture of chemical products before the war, and in their distribution throughout the world's markets, was due primarily to the perfection of the Empire's facilities for industrial research. The importance of this factor in national life was not appreciated in an equal measure by other rival lands. It is, however, now felt in most European, and in many non-European countries, that no time is to be lost in arranging for a much more exhaustive and comprehensive scheme of industrial research than has hitherto been the rule.

In our own country there is an admirable start in this direction, but much more needs to be done.

The results obtained during the past few years, in certain restricted fields by the Bureau of Standards, the Bureau of Mines and various bureaus of the Department of Agriculture, reveal, in a striking manner what can be done on a vaster, more comprehensive scale. There is an enormous opportunity for combining public and private initiative. In the rapid organization and mobilization of the country's resources for the vigorous and successful prosecution of war, we are witnessing the creation of a mechanism, which should function normally during peaceful times in assuring the highest efficiency and the steady, swift advance forward of our manifold industries. Some of them—not many—reveal admirably organized individual efforts to insure adequate progress in the field of research. Reference may be made here to the fine equipment of some chemical companies, such as the du Pont Company, and constituent parts of the recently organized National Aniline and Chemical Co., Inc., the Eastman Kodak Co., and a few others.

What we need, however, is a much higher degree of combination and co-ordination, such as is aimed at across the waters.

The British "Advisory Council for Scientific and Industrial Research" is dealing with this problem in a systematic, intelligent manner, collating all available material from other countries and focussing the attention of the British Government and the British people upon the imperative necessity of prompt and generous action.

The Council has just issued its first publication, based upon elaborate studies of what is being done in this country to advance industrial research, made by A. P. M. Fleming, M. I. E. E.

His paper entitled "Science and Industry: Industrial Research in the United States of America," is finely illustrated and is a well-balanced portrayal of what American experience and practice can offer in a suggestive, educational way to British industries.

In a closing chapter Mr. Fleming summarizes his conclusions and recommendations. These apply frequently with such pertinence to the general status of chemical industry in our own country, and more specifically to the interests of the coal-tar chemical industry as it is struggling to gain a permanent foothold, that we quote them at some length:

"While there are prominent British manufacturers who appreciate the potentialities of industrial research, it must be conceded that as a body they consider such investigation to be an expensive luxury. On the other hand, during the past two years there has been disclosed in British industries an enormous latent capacity for adaptability to entirely new lines of manufacture, many of which have depended for their development upon scientific research. The research facilities, however, that have been created to such an extent during the past two years are as yet quite disproportionate to the magnitude of British industry, and it is highly desirable that the present awakening to the use of science should be fostered, and research facilities suitably organized.

"For this purpose it is essential that any national scheme of research be designed on ideal lines to which existing organization should be subordinated, so that in this way the development can proceed progressively until ultimately the plan is consummated.

"From the standpoint of the individual firm, the most effective weapon in industrial competition is the application of new knowledge resulting from research applied to some immediate industrial problem. In pursuing an investigation, however, toward a definite goal, it is well known that many promising ramifications are often disclosed, which, when followed, lead to results that may be more valuable even than the original objective. In this way it may often happen that a research carried out in the interests of one industry may lead to results which prove invaluable if applied to some quite different industry. The higher forms of research, more especially those in the field of pure science, should therefore be carried out on national lines, so that any results that are derived can find application in one or other of the numerous national industries.

"It is even more important that such research be organized on lines which will link up the scientific resources of the Empire. The work of the Institute of Science and Industry in Australia, and the research now being developed by the Canadian Pacific Railway, together with similar efforts that may be made in other parts of the Overseas Dominions, should be linked up with a national scheme in this country. Apart from the interchange of scientific knowledge, such an Imperial scheme would assist the utilization of raw materials, and in this way foster the development of the natural resources of the Empire. It is quite as important for manufacturers in Great Britain to interest themselves in any means which will improve and cheapen their raw material supplies as it is to direct scientific methods to the cheapening of manufacturing processes. An Imperial research organization might not only result in the development of means for cheapening the production of raw materials, but also, where new materials are discovered in the Overseas Dominions, assist in finding suitable outlets for their use.

"An important consideration affecting industrial conditions after the war is that considerable manufacturing resources, comprising plant, machines, tools, and trained labor will have accumulated, some of which may be turned to national benefit if they can be adapted to the manufacture of products hitherto obtained from abroad. In thus developing new lines of manufacture, organized research may be of very considerable benefit. In order thus to meet international competition it is necessary to bring each manufacturing process to the highest degree of efficiency by the elimination of haphazard and wasteful methods.

"With regard to the financial aspect of research, experience in the United States shows that the efficiency of a well-organized laboratory increases considerably with its size, and, moreover, only the large laboratories can employ methods of full-scale manufacture, which not only materially assist in the efficient development of new products, but also secure considerable revenue from the sale of commodities produced in this way. Thus the annual maintenance cost of the laboratory of the Eastman Kodak Company is $150,000, representing less than 1 per cent. of the annual profits of the company.

"Viewing American experience in the light of the considerations described, the following seem to be the the most important of the alternative schemes of research that might be employed in Great Britain:—

(*a*) Research laboratories in individual works.
(*b*) Research laboratories for a group of works in the same industry.
(*c*) The centralization of research in the universities or colleges.
(*d*) An Imperial centralized laboratory for the whole of industry.

Individual Works Laboratories.

"The most effective way of conducting industrial research would be to equip each works with its own laboratory. By this means the most intimate needs of the firm could be studied and effectively dealt with, and such a close combination of works, organization, and scientific investigation would probably result in a number of very efficiently conducted firms. It is clear, however, that only the largest works could support laboratories on an extensive scale. An enormous amount of overlapping would occur, since each laboratory in the same industry would probably carry on very similar work; most firms could not stand the financial burden of such a laboratory; there would be an insufficient number of really first-class research men available to staff such laboratories; and, it would hardly be practicable to carry out investigations of a purely scientific character, since the possibilities of turning a large part of the results of investigations to account in any one firm or industry would be comparatively small. Further, while by such means individual firms would be able to compete keenly with each other, their scientific resources would not be organized in the best way to meet competition in international markets.

"Complete research laboratories in individual works only appear possible in the case of very large organizations, although, as noted later, individual laboratories adapted for dealing with immediate needs are highly desirable when operated in conjunction with a larger research scheme.

Research Laboratories for a Group of Works in the Same Industry.

"Different firms in the same industry employ very similar manufacturing facilities, and in order that the greatest possible improvement can be made in tools, methods, and processes, it is desirable that the various firms should pool for their common benefit all the experience and research facilities they possess that will assist this object. For this purpose a central laboratory might be arranged for each industry or for a group of similar firms in the same locality.

"In those cases where firms have secret processes in connection with which investigations are required, these would be carried out by each firm on its own account. Many such processes, however, are of much less importance than is commonly supposed, and the experimental work thus involved would probably represent not more than a small portion of the total research requirements.

"Such arrangements are already in vogue to a limited extent in this country; for instance, a central laboratory for research work is maintained in the Sheffield district, where two of the largest steel firms in intimate commercial alliance support a common research laboratory. In other cases facilities for common research have followed on the fusion of the commercial interests of two separate firms, as has occurred in the pottery district. While it may be argued that the pooling of resources may entail some self-sacrifice on the part of larger firms, from which their smaller competitors would benefit, this is probably not a very important matter, since many processes could for financial reasons only be taken advantage of by the largest firm. In any case, however, while such combinations might in the case of some firms involve a temporary loss, improvements arising from joint research would probably enable every firm to recoup far more than it expends, owing to the increased amount of business and greater working economy arising from the application of the discoveries made. The time was never so opportune for such co-operations, and never have competitive firms been so ready to share mutual interests.

The Centralization of Research in the Universities and Colleges.

"The most extensive facilities for research in this country are at present possessed by the technical colleges and universities, and these are to some extent employed for dealing with miscellaneous investigations required by local industries. These facilities might be arranged so that each university served as a research station for one or other of the principal industries.

"There are, however, many objections to this course. The function of the modern university is to educate, and its equipment and staff should be directed primarily to this end; the staff is not, as a rule, intimately in touch with industry, and the amount of research necessary for the industries of this country is far beyond all the resources of the universities. On the other hand, research is one of the finest possible means of educating young men for industrial employment, and consequently every encouragement should be given to graduates to pursue some research work under the guidance of an experienced experimentalist. For educational purposes the character of the research should be such as to develop the student's capacity to think for himself and increase his powers of observation and logical deduction.

"At the present time, with the exception of the work of the National Physical Laboratory, most research in pure science is carried on in university laboratories, and such work is eminently suited to the capacity of the university staff. From the experience of the States it is clear that to be most effective in an industrial sense research investigations should be undertaken by a staff specially devoted to the purpose, and as far as possible also with equipment not required to be used for teaching purposes. In such cases there appears to be very little to be gained by attaching such special research laboratories or experiment stations to the universities. They might equally well be placed at other and possibly more convenient centres of industry.

A Centralized Imperial Research Laboratory for the Whole of Industry.

"The single laboratories dealing with the research requirements of each industry might all be grouped together in one centre, and controlled by a board largely represented by manufacturers.

"Such a combination would possess many advantages over separate laboratories. For instance, the cost of maintenance would be less, and through the common use of library, power supply, machine and other workshops, the first cost would also be lower. By far the greatest advantage, however, would be the benefits derived from the corporate life of such an institution, and the free interchange of experience and discussion of research work between the staffs of the various industrial sections. As already pointed out, in the pursuit of an investigation much new knowledge may be disclosed which has an important bearing on industries quite different from that of the original objective. In a laboratory confined to the needs of a single industry such new knowledge might be entirely lost, or if put on record might not come to the notice of those to whom it would be of the utmost benefit. In the centralized institution such a risk would be reduced. Further, such a laboratory would be best adapted for co-operating with the research institutions in the Overseas Dominions, and in fact would serve as a scientific focus for the whole Empire.

"The staff of the laboratory would comprise a senior grade, representing the directors or heads of each industrial division; an intermediate grade, representing the principal body of research men; and the juniors, who would principally consist of graduates recently drawn from the universities. The senior staff would be permanent. The intermediate men would be continually migrating into industry as their value to manufacturers became appreciated, and this tendency would be encouraged so as gradually to permeate industry with well-trained scientific men. The junior staff would be permitted to employ part of their time in the laboratory in preparation for higher degrees, and in this way their appointment would be equivalent to a fellowship such as that tenable in some universities for graduate research, with the advantage that the training period would be spent under first-class research men, and the work undertaken would in most cases be of live industrial interest. The juniors would in course of time be promoted to the intermediate work.

"In order to utilize every scientific asset the staff and facilities of the universities and of private research workers would be registered and incorporated as auxiliary to the central laboratory. The university staffs could from time to time for convenient periods take up research work in the central organization itself, and in this manner keep closely in touch with modern progress.

"While the function of the laboratory would be primarily to deal with problems confronting manufacturers, a considerable amount of original research in pure science would need to be done. On the other hand, the laboratory should be provided with means to carry on the actual manufacture of new products until this is undertaken by a regular commercial concern. While the first cost and the maintenance for some years would have to be provided out of public funds or by levy on the profits of industry, the institution ought to become self-supporting in time from the sale of products manufactured and from the licenses granted to manufacturers in connection with new or improved materials, processes, or tools.

"Under present manufacturing conditions it frequently happens that the user of materials has to carry out the research necessary for their improvement. Fundamentally this practice is wrong, and such work should be carried out by the supplier. With the help of a centralized institution it would be possible for each branch of every industry to have its own research carried out there under the guidance of its governing body or trade association.

"The importance of the collation of all scientific information, not only that pertaining to contemplated research, but also that of use in industry generally, has already been alluded to. The centralized organization affords the best possible means of doing this, and also of disseminating it to those to whom it will be the greatest value. The laboratory would also issue bulletins of the work it carries out, and might also undertake the preparation of text-books in the most important and advanced branches of technology. The heads of the different sections of the laboratory would require to keep in close touch with the firms of the industry they represent, in order to carry out where necessary full-scale manufacturing experiments in works, and with the National Physical Laboratory, which would deal with all matters pertaining to standards and research connected therewith.

"The establishment of such an organization would tend to cause firms to install their own laboratories in co-operation with the central laboratory for dealing scientifically with manufacturing troubles and special research problems incidental to their own products.

Conclusions.

"The most important conclusions that emerge from the above facts and considerations may be shortly stated.

"Industry is the basis of national prosperity, and every resource should be used to facilitate its progress. The success, however, of any comprehensive scheme of research depends largely upon the attitude of the manufacturers, and it is therefore of high national importance that they should not only appreciate the value of the application of science in industry, but also co-operate in assuring that it is applied systematically and sufficiently. Among the questions that arise immediately out of the need for industrial research is that of the education and training of men for all grades of industrial employment. The full benefits of scientific investigation will not be obtained unless the results are applied by suitably trained men. There is urgent need for consideration on national lines of means for the better education and training of youths who will be the future skilled workmen; and the demand expressed by many for a more important place for science in education needs no emphasis. It is not less necessary to give attention to the scientific training of those who proceed to the higher positions in industry from the universities, and particularly to impart to such students a thorough knowledge of the fundamentals of manufacturing economics. The development of research on a large scale, and the consequent possibilities of absorbing and lucrative employment, will tend to attract to the ranks of industry many of the ablest young men who nowadays enter non-productive professions. In this way their value from a national point of view will be immeasurably increased.

"A new phase in industrial and economic life is commencing, and its development will be governed very largely by the extent to which new scientific knowledge is obtained and turned to the benefit of mankind. It is by the progressive use of research, every advance of which opens up ever wider industrial possibilties, by the fullest employment of the nation's inherent manufacturing capacity, and by the wise co-operation of labor and capital, that the prosperity of this country can be assured."

A New Factor in the American Dyestuff Industry

For over a year there has been more or less discussion by all interested in the evolution of the American coal-tar chemical industry, as to the possibility of the entry into this field of the E. I. du Pont de Nemours Company of Wilmington.

The company has expanded enormously during the past three years its plant for the manufacture of the high explosives, picric acid and trinitro-toluene. It has created a fine plant for the production of aniline and several of its derivatives such as diphenylamine and tetra nitro-methyl-aniline, used as stabilizers, etc., for high explosives.

It was evident that the vast equipment would find but a limited field of usefulness at the end of the war and of the abnormal demand for munitions, unless it was utilized directly for the manufacture of more peaceful coal-tar compounds.

This fact has been fully recognized by the directors of the company and the decision has been made to embark extensively upon the production of artificial dyestuffs. The company's plans are formulated in the following announcement:

"We desire to announce our decision to enter the coal-tar dye industry.

"The reasons for this step might be briefly summarized as follows:

"Our development during recent years in the explosive and in several other branches of the chemical industry brings us now to the logical result of undertaking in a broad and comprehensive way the manufacture of synthetic dyestuffs and kindred products.

"The explosive and coal-tar dye industries are closely allied; both require intermediates which we manufacture in a large way; both are highly scientific and thoroughly developed and both require large technical and commercial organizations.

"We start with (1) the necessary raw materials, products of this country, and are therefore not dependent upon Europe; (2) a chemical and enginering organization second to none in magnitude and scientific attainment; (3) unequalled plant and laboratory facilities, and (4) an adequate commercial organization.

"We know the needs of the various consuming industries, that is, cotton, calico printing, wool, silk, leather, paper, paints, printing inks, etc., and plan to meet them in due time.

"Our development will necessarily be progressive, starting with certain products and increasing as rapidly as possible.

"Our technical laboratories, with a competent staff of experts, will be at the disposal of all consumers in all branches. We shall establish, and hold to, the highest standards of quality. Our prices from the start will be based upon our cost of raw materials and labor, with the end in view of establishing at this time, under abnormal conditions, cordial and enduring relations with the consuming industries.

"Back of all this is the compelling force of the country's need; if as the result of the combined efforts of all, the United States can in time, become self-contained, we are quite certain that we voice the sentiment of the consuming industries in predicting that the effort will not have been made in vain."

This announcement has the right ring!

Taken in connection with the recent merger of leading coal-tar chemical interests into the powerful "National Aniline and Chemical Co," it means that our country will possess two powerful dyestuff organizations, either one of which is potentially able to rank at an early date with the strongest of the German or Swiss color corporations. As a matter of fact the du Pont Company employs more chemists than the famous "Badische" Company.

It is an eminently wise decision to enter immediately upon the field, and gain all possible experience, technical and commercial, before the time approaches to discontinue the manufacture of explosives on the existing scale, and to face the problems of foreign rivalry, certain to accompany the resumption of normal international exchanges.

With exceptionally ample capital, and a finely organized staff of experts already familiar with the problems of coal-tar chemistry, this action of the du Pont Company contributes mightily to assure the future of our American industry. The fact alone that a corporation with a capital of $240,000,000, feels that it can safely enter upon this new field and hold its own against the prospective competition of European rivals possessing the broad experience of several decades, will do much to strengthen the determination of lesser factors, ambitious to share in building up our color industry, but hesitating over possible risks.

Government Activity in the Field of Color

There has been some misapprehension in industrial circles with regard to the nature of the work now carried on in bureaus of the Departments of Commerce and of Agriculture on the subject of colors.

The Bureau of Chemistry in the Department of Agriculture has established at Roslyn, Va., a branch laboratory, in which, under the intelligent direction of Dr. H. D. Gibbs, a number of important lines of research connected with the production of important coal-tar intermediates and the manufacture from the same of dyestuffs are being actively pushed. This class of investigation has been highly developed in the great color works of Germany and is supplemented by a vast amount of closely related research in the laboratories of the state-supported universities and technical schools. This close co-operation between governmental institutions and industrial effort is one great source of the power of the German coal-tar color branch. It contributes not only to the ability to maintain an economical supremacy, but also to the advance forward in tinctorial invention. The possibilities of discovering new classes of synthetic dyes, capable of displacing many standard favorites in point of brilliance, fastness, ease of application or cheapness, are just as marked today as at any time since Perkin made his epochal discovery. The nation whose chemists neglect to emphasize the importance of extensive and varied research, cannot hope to successfully retain a dominant position in its own or in foreign markets.

It is in full recognition of this fundamental fact that the men of science in Government employ regard it as of paramount importance to establish upon a firm basis the requisite organization for carrying out such forms of investigation in the chemistry of coal-tar compounds, as will enable us, ere long, to contribute notably to its progress, and stand upon an equality with the large corps of capable and versatile men in German and Swiss laboratories, who steadily broaden the outlook of the dyestuff industry.

Full success can be attained only when the same restless, determined spirit becomes evident among the chemical staffs of our colleges and universities, and especially of the companies actively engaged in creating our new industry.

The Bureau of Chemistry at Washington will freely place its results at the service of private initiative and co-operate with the domestic industry wherever it can advance the growth of the domestic dyestuff industry.

Logically this should lead to a very close co-ordination of efforts upon the part of Government chemists and of those connected with our leading color firms. On a small scale, all concerned must manifest that same fine spirit of co-operation, which characterizes our nation, as a whole, in facing the tremendous problems of war.

There has been an assumption that the question of the standardization of dyestuffs, which has been a topic of serious and widespread discussion during the past few months, has been taken up actively by the Bureau of Standards, in the Department of Commerce. This is by no means the case. Dr. S. W. Stratton, the director of the Bureau of Standards, has outlined recently, in great clearness, the exact nature of the work under his supervision.

According to his statement, for several years the bureau has been experimenting toward a standardization of color, not as a substance, but as a physical phenomenon, as the color of butter, of cloth or of paper. This is entirely distinct from a standardization of dyes. The Bureau of Standards seeks to make it possible to point out what is a standard color so that it can be duplicated at any period of time, and is trying to establish methods of so determining the quality of colors. The bureau is seeking to establish standard colors of dyes, but not a standardization of dyes themselves.

The question of the standardization of dyestuffs is a very complex one. It might very properly come within the purview of the national Bureau of Standards. This would mean, however, an enormous extension and enlargement of the chemical side of the bureau's work. At present sentiment in the bureau is averse to increasing the already numerous spheres of activity, in which such admirable work is being done —work which commands respect in all countries.

Phenol from American Coal Tar

The admirable way in which American coal-tar chemists are dealing with the problems connected with the exact and economical utilization of our domestic supplies of crude materials, is well illustrated in the exhaustive study on the determination of phenol in crude carbolic acid and tar oils generally, by Mr. J. M. Weiss and Mr. C. R. Downs, to be found in the next section of this issue of the CHEMICAL ENGINEER.

The method evolved by them facilitates, in a remarkable degree, the work of establishing the commercial value of the current sources of phenol. As a result of the entirely abnormal demand for phenol, in connection with the enormous demand for picric acid, the manufacture of the synthetic product has been established upon American soil on a vast scale, and has been brought to a high degree of perfection.

To some extent the manufacture has been materially modified through the employment of chloro-benzene as a starting point. There are, apparently, certain advantages in making use of this compound and in nitrating it to dinitro-chloro-benzene, before the chlorine in the molecule is replaced by hydroxyl, and dinitrophenol is obtained. The latter can be nitrated further to picric acid, or be used directly in the production of Sulfur Black and of other colors.

It is not impossible that, after normal conditions have been restored, such indirect syntheses of phenol derivatives may prove to be more economical than methods in which phenol itself is taken as the starting point.

There is, however, a very large demand for pure phenol, in the form of crystals or liquid. This should be met most advantageously by employing phenol separated by fractionation from coal tar, and suitably refined.

There is no very wide margin between the cost, under normal conditions, of manufacturing synthetic phenol from benzene and the current rate for the product early in 1914. This fact may act as a check to excessive rises in price for natural phenol, in the future.

We may logically expect that, at the close of the war, our customary consumption of phenol will be covered by a supply obtained exclusively from American coal tar. The equipment requisite for the purpose is now present and the tariff act of September 8, 1916, affords a moderate but fairly ample protection for the domestic product in a more or less refined condition.

Prior to the war there was little inducement to create an American phenol industry. In both England and Germany the industry was highly developed and perfected. The supply of coal-tar from American coke plants was limited, and totally inadequate to furnish the amount of tar oils required for use in preserving railroad ties, telegraph poles and the like. Great quantities of creosote oil were regularly imported from Europe. Market conditions were such that it was economically more profitable to use the entire stock of domestic tar oils for preservative purposes, rather than to extract the fraction of pure phenol.

At the end of the war conditions will be totally changed. The recovery of coal tar is vastly augmented. The newly-created American dyestuff industry will call for considerable amounts of phenol, the various cresols and possibly the xylenols. In addition, anthracene will be in steady demand for the manufacture of alizarin and numerous other colors derived from this hydrocarbon. As a result, the whole mechanism for securing the higher boiling constituents of coal tar, in relatively pure forms, is being perfected to such a degree that we can be independent of European sources. This will naturally mean much to the American dyestuff industry and to all branches using coal-tar crudes and intermediates as raw material.

Accurate analytical data and methods are essential to the successful evolution of these phases of the coal-tar chemical industry, and all connected therewith will accord a hearty welcome to the valuable study of Mr. Weiss and Mr. Downs.

Annatto from Porto Rico

In these days of widespread effort to emancipate ourseles from dependence upon foreign sources of drugs and dyes, attention may be profitably directed to our insular possession of Porto Rico as a region from which we can easily secure our normal supply of the natural dyestuff, annatto.

The consumption in the United States during the fiscal year 1913-14 of this coloring material was 507,000 pounds, the invoice value of which in the countries of origin was $25,340. The average invoice value per pound was 5 cents. In the fiscal year 1915-16 the import mounted to 603,000 pounds, the invoice value being $69,800, or 11.6 cents per pound.

The chief sources of annatto have been Brazil, Guiana and the French West Indies. Zanzibar and Hawaii export limited amounts. Of late years Porto Rico has contributed to the world's market. In the fiscal year 1913-14 the export was 212,000 pounds. It increased in the year following to 337,000. The price per 100 pounds, in 1913-14, at Porto Rican ports, was $4 to $5. At present it ranges from $13 to $15, according to quality.

The coloring material is found in the fruit of the bush or small tree known as *Bixa orellana,* which grows wild in Porto Rico, but is frequently cultivated in the other countries mentioned above. There is no reason why the shrub or tree should not be made in Porto Rico the subject of systematic and intensive cultivation, of as intelligent a nature as that which characterizes the present effort in India to increase the output of natural indigo and standardize the product. It might prove a valuable factor in the agricultural assets of our island possession, the climate of which seems admirably adapted for the growth of the tree and the maturing of the fruit.

This fruit consists of capsules as large as walnuts, in which the seeds are embedded in an orange yellow, sticky pulp. The treatment of this pulp, which contains the coloring matter, is usually quite primitive. In some places the seeds are removed, at the outset, from the pulp. In other regions it is allowed to stand in water for some time, undergoing a. sort of fermentation, after which the seeds are separated by the use of sieves. In still other sections the contents of the capsules are extracted directly with boiling water. A soft mass separates out from the water, and this, after being freed as much as possible from the water, constitutes commercial annatto, a bright, yellowish red paste.

The pulp at this point contains two distinct coloring matters. One, a light yellow, is soluble to quite an extent in water. The other, of a resinous nature, is bright red, insoluble in water, but soluble in alcohol and solutions of the alkaline carbonates. The residual water, after the separation of the annatto proper, is colored bright yellow.

Annatto paste is prepared for exportation in various ways. The most common is to press it into cakes weighing 2 to 3 pounds, which are wrapped in banana leaves and then packed in casks. Annatto from the French possessions is almost always shipped in this form.

Brazilian annatto is pressed into the form of small, hard, compact cylinders, externally of a brown color, internally a brilliant red. The British market is usually supplied with these cylinders.

There is an increasing tendency to ship the soft paste itself, containing about 60 per cent. of water, and packed in tins or kegs. In Europe, especially in France, annatto is submitted frequently to a process of refining or concentration, and is put upon the market in the form of tablets, containing four times as much coloring matter as the cruder material, shipped from the tropics.

The seeds contain a relatively small amount of color, and are exported when market conditions are favorable, as at present.

The young bushes of *Bixa orellana,* after the growth of a year and a half, yield from one-half to one pound of this crude annatto, and there is a steady increase in the yield with each additional year of growth.

There is a widespread use of annatto in coloring confectionery, butter, cheese, various sauces, and other articles of food. The color is also employed for varnishes, lacquers, wall paper, fancy papers, water colors and oil colors. In calico printing there is a limited use, as well as in the dyeing of silk, to which annatto imparts a particularly bright and lively tint. The very fugitive character of the color prevents, however, any very extended use in the textile industries.

In New York markets the best grades of annatto now command $33 to $34 per 100 pounds. The seeds sell for $11 to $14.50.

The American Supply of Toluene

There is much to indicate that the demand for toluene in this country will shortly become as pronounced as was the case in 1915. The managers of coke-oven plants and tar-distilleries report that inquiries for the article are multiplying at a rapid rate. As hitherto, nearly all is required for transformation into trinitrotoluene—TNT. The notable increase in demand results from the completion of the plans of the Ordnance Bureau, which evidently involve the ordering of vast amounts of high explosive shells.

Practically all of the output of toluene for months ahead was engaged some time ago, to meet the orders of our European allies and current needs of the American military establishment.

It will be difficult to bring about any rapid increase in the output of toluene from coke plants. Practically all of our modern by-product coke-oven installations are now equipped with benzol scrubbers, which recover nearly all of the benzene, toluene and xylene present in the current of gas issuing from the retorts.

There would appear to be but two methods of relieving the shortage in this class of high explosives, unless the ordnance experts devise methods of utilizing guncotton and dynamite for the purposes in view.

The first method is to increase the relative amount of picric acid used for shells. This would mean falling back to the conditions which existed prior to the recognition of the marked advantages of TNT, as far as regards safety and convenience of handling, which much more than counterbalance its slight inferiority in explosive power, weight for weight.

In this connection it might be pertinent to inquire whether experiments have been conducted as to the desirability of mixing the two materials. It is possible that to some extent, if not entirely, the disadvantages and danger associated with the use of picric acid might be modified or lessened when the two explosives are mingled or found together.

The second method is to adopt widespread measures for recovering the benzene and toluene, present in our illuminating gas. This would involve the erection of benzol scrubbers, quite similar to those employed in coke plants.

As the luminous properties of gas depend largely upon the presence of the vapors of these aromatic hydrocarbons, it would naturally be necessary to carburet the gas on leaving the scrubbers, in order to introduce an equivalent quantity of other non-saturated hydrocarbons.

All of this involves additional plant in our gas works, which, however, can be utilized in times of peace, as there will be an increasing demand for benzene and toluene to replace gasoline for use in motors.

Should the great conflict be materially prolonged and the intensity of the artillery, as a dominating factor, be notably increased, it is evident that American coal-tar chemists will play a prominent part in insuring final success.

Situation of the Leading German Artificial Color Company

The famous "Badische Anilin und Soda Fabrik" of Ludwigshafen, on the Rhine, the strongest of the German companies engaged in the manufacture of colors, has published its balance sheet for 1916.

The figures are of peculiar interest at the present time, as are also the accompanying statements of the directors, although they reveal little concerning the specific activities of the great organization. It is generally understood that the manufacture of dyestuffs has been largely replaced by that of munitions of war and hospital supplies. The company is also doing important work in the synthetic production of ammonia, which is transformed by Ostwald's method into nitric acid.

From the report it is seen that while in 1915 creditors stood for 18,750,000 marks, roughly a third of the share capital of 54,000,000 marks, the figures now stand at no less than 116,000,000 marks, or more than double the share capital. This extraordinary increase is explained by the Government advances, which are repayable at far distant periods.

Advances to the Government have resulted in increasing the investment account from 79,790,000 to 111,390,000 marks. The Augusta Victoria Mine has not come up to expectations and has, it is stated, suffered from the extraordinary labor difficulties. To safeguard supplies of lignite, two lignite mines have been acquired. On the other hand, shares of the Union of Chemical Works at Zeitz, which under the changed circumstances were not considered of special value, have been sold.

The figures of the published balance sheet, in marks, are as follows:

	1914	1915.	1916.
Brought forward	2,236,609	2,627,800	2,893,875
Profit on products. .	28,632,148	33,867,711	40,614,837
Interest	591,891	1,150,017	2,012,462
Total	31,460,648	37,645,528	45,521,174
Expenses	5,706,150	5,286,644	5,822,960
Interest on loans.	950,175	922,444	886,309
Written off	9,005,517	11,607,571	12,369,258
Profit	15,798,806	19,828,871	26,442,647
Extraordinary reserve. . .	3,000,000	3,000,000	3,000,000
Dividend	8,550,000	10,800,000	10,800,000
Dividend per cent.	19	20	20
Bonus of 8 per cent.	. . . .	. . . .	4,320,000
Share in profits.	1,621,007	2,134,995	3,072,895
Carried forward	2,627,800	2,893,875	2,893,875

As to the company's activities, the directors say that a further number of branches of the works had to be rearranged, owing to war requirements. The sale of dyes, partly owing to stocks lying abroad, partly owing to added materials, has continued to a certain extent, also the making of nitrogen has further increased.

In this connection the Munich *Neueste Nachrichten* declares that, even if the final result is satisfactory, it should be borne in mind that the competition which has arisen, both in enemy and neutral countries, is profiting by the long duration of the war, and consequently the recovery of many former German markets abroad is rendered much more difficult, and, in any case, will be possible only by great efforts and at the cost of special sacrifices.

Reports of a recent raid by French military aviators along the upper Rhine are to the effect that the works of the "Badische" were destroyed by bombs early in July. No details are given. As the establishment covers such a vast area it seems improbable that more than a comparatively small portion of the plant could be put out of commission by the hurried efforts of an aeroplane squadron.

Export Licenses

The wording of the recent Proclamation, requiring export licenses for a variety of articles, is somewhat vague in regard to the chemicals which fall within its purview.

Upon the recommendation of the Exports Council the term "Explosives" is now stated to include the following chemicals:

"Ether, alcohol, sulphur, sulphuric acid and its salts, acetone, nitric acid and its salts, derivatives of benzol, phenol (carbolic acid) and its derivatives, derivatives of toluol, mercury and its salts, ammonia and its salts, glycerine, potash and its salts, all cyanides."

The derivatives of benzol, of toluol and of phenol form a decidedly extensive class, including most of the artificial dyestuffs now manufactured in the United States. To officials not familiar with the vocabulary, and with the nature of the various classes of compounds, coming into consideration, there will be no little difficulty in applying this rule, and in avoiding the danger of making it a serious handicap on the export of a number of coal-tar compounds non-susceptible of use as explosives or in the manufacture of explosives. A relatively very small list of derivatives would fall in the two categories, and they could easily be specified by name.

COAL-TAR CRUDES

The Determination of Phenol in Crude Carbolic Acid and Tar Oils*

By John Morris Weiss and C. R. Downs

INTRODUCTION

The purpose of this paper is to describe a method which is capable of giving accurate results for the determination of phenol in mixture with cresols, higher phenols, and neutral oils.

Many methods for the determination of phenol have been proposed. Most of these, however, are designed to serve as an assay of pharmaceutical phenol, and are of no value for the purposes which this paper is designed to cover.

Leube[1] used a colorimetric method with ferric chloride. Nietsch[2] converted the phenols into sulfonates, formed the barium and lead salts and made a determination of the metal content of these salts. Carre[3] converts the phenol to picric acid and makes a colorimetric determination. None of these methods are applicable for even an approximate assay of the real content of phenol in a crude acid or tar oil.

Warnes[4] gives three very empirical methods for testing carbolic acid. The results give only the melting point of a definite volume percentage fraction of the original acid, and though comparative between different samples, does not give any real indication of the actual amount of true phenol present.

Lunge[5] gives a table showing the lowering of the fusing points of mixtures of para-cresol and phenol according to tests made by Lunge and Zschokke. This table is patently useless for estimation purposes, as, in ordinary cases, meta- and ortho-cresols are also present in varying proportions, and affect the melting point to a very considerable degree.

Later Lunge[6] gives a method of examining crude phenols (carbolic acid) for its yield of crystallizable phenol of a melting point from 15.5 to 24° C. This is known as the method of Lowe, and was in use among English tar distillers for some time. The crude acid is fractionally distilled and the melting point taken on a definite per cent. by volume of the crude acids. The test is, however, more a specification for quality of crude acids than a method of analysis. Lunge further states that for the purpose of "acquiring good practice in this method" mixtures are made of various content of pure crystallized carbolic acid and of cresols (preferably tar cresols, *i. e.*, a mixture of the three isomers) and the melting points of these mixtures are previously determined. No account is taken of variation in melting point due to variation in the interproportion of the three cresols. As Lunge himself points out, the relative proportions of the three cresols in coal-tar are not constant. No attempt was made to take advantage of the differences in specific gravity between phenol and the cresols. The method is very crude and would give only very approximate results.

Stochmeier and Thurnauer[7] extract tar acids from carbolic oil, separate the hydrocarbons from the carbolate by steam distillation, liberate the tar acids and fractionate them. They then use Koppeschaar's bromination method[8] on the fractions, and use special factors for the fractions containing the cresols. The titration of such mixtures is clearly not allowable as shown by Vaubel.[9]

In 1912 one of the authors[10] made, perhaps, the first published attempt to develop a rational method for the estimation of phenol in crude carbolic acid and tar oils, and it is along the general lines of that method that the method given in the present paper was developed. The method was fairly accurate, giving results within about 10 per cent. of the phenol present. The range of the series of mixtures, however, was not close enough and the cresols available at that time were not quite so pure as today. Moreover, the recent increase in value of phenol has made a more accurate method necessary, whereas in the past the close determination of phenol was not of prime importance. In the present method the procedure has been considerably changed and amplified, and a much more complete series of mixtures of known composition has been prepared and studied.

Very recently, while this paper was in course of preparation, René Masse and M. H. Leroux[11] published a method which is in some respect very similar to the method submitted by the authors of this paper. We have taken the liberty of reproducing the determination curve (see Fig. I) given by them, in this paper, and plotting on it points as found in the examination of our own series of mixtures. At some points the error can be very great. They use solidification point alone for their determination, and with variation of the proportion of the cresols among themselves, there might be an error of 2.6 per cent. at the 75 per cent. point, of 1.8 per cent. at the 70 per cent. point and of 4.4 per cent. at the 65 per cent. point. This will be seen more clearly by a reference to the curve. Masse and Leroux used a mixture of 50 per cent. *o*-cresol and 50 per cent. of a mixture of 60:40 of meta- and para-cresols, for the basis of the determination. In

---

*From the Journal of Industrial and Engineering Chemistry, Vol. 9, No. 6, June, 1917.

[1] *Dingler's polytech. J.*, **202**, 308.

[2] *Jahresber. der. chem. tech.*, **1897**, 1036.

[3] *Compt. rend.*, **1891**, 139.

[4] Warners, "Coal-Tar Distillation," **1913**, 166-7.

[5] Lunge, "Coal-Tar and Ammonia," 5th Ed., **1916**, 277.

[6] *Ibid.*, 782.

[7] *Chem.-Ztg.*, **1893**, 119, 131.

[8] *Z. anal. Chem.*, **1886**, 233.

[9] *J. prakt. Chem.*, **48**, 74.

[10] *J. Franklin Inst.*, **1912**, 683.

[11] "J. Usines á Gas," abstracted in *J. Gas Lighting*, **136**, 587.

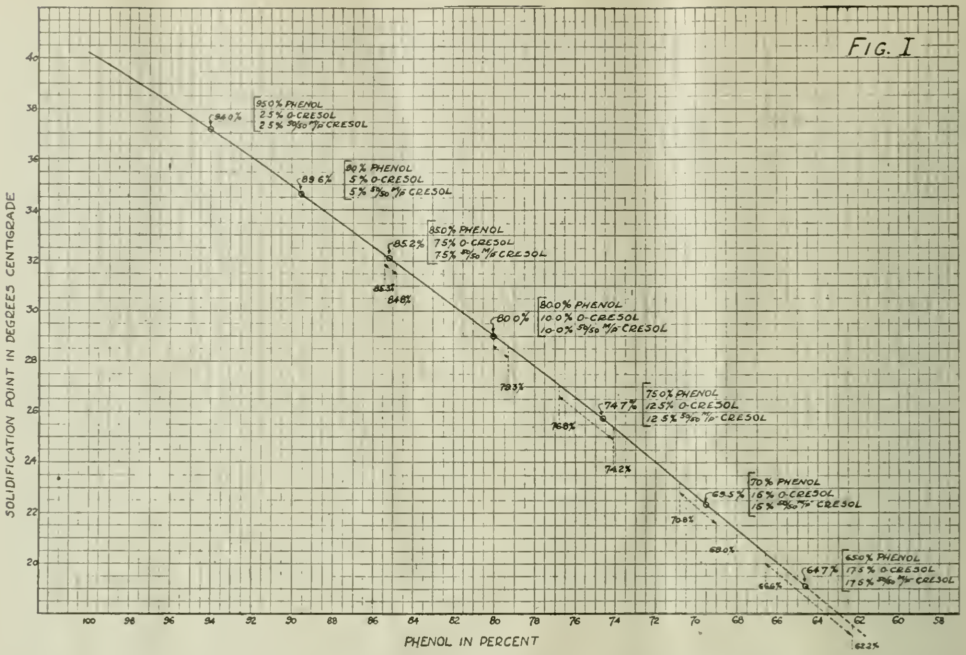


FIG. I

our work we used a 50:50 meta-para-cresol mixture (as naturally occurring in our oils) and varied the relation of the ortho-cresol to this. In the following table we have shown the variation in percentage between their curves and ours on the mixtures which correspond most closely to their proportions:

TABLE I.

Per cent Phenol	Per cent o-Cresol	Per cent m50/p50 Cresol	Per cent Variation
95	2.5	2.5	1.0
90	5.0	5.0	0.5
85	7.5	7.5	0.2
80	10.0	10.0	0.0
75	12.5	12.5	0.3
70	15.0	15.0	0.5
65	17.5	17.5	0.2

This shows their curve to be quite correct if the proportion of ortho-cresol to meta- and para-cresol be equal, but this is not generally true of tar oils. Therefore, the use of the simple solidification point curve is insufficient.

In general, their directions for the distillation of the liberated acids are fairly complete, as is also their description of the method for determination of the solidifying point of the fractions. There are, however, a number of points in the handling of tar acids to remove neutral oils, on which their directions are not explicit, and here there is considerable chance for the introduction of serious errors. These errors may be further increased in the procedure for the determination of the phenol content of a tar oil.

The physical properties of the cresols and of phenol have been variously given in the literature (see Table II).

TABLE II.

	Melting Point	Boiling Point	Specific Gravity
Beilstein (a)			
Phenol	42.5 to 43° C.	178.5 to 184.1° C.	1.0906 at 0°
o-Cresol	30	190.8	1.0578 at 0°
m-Cresol	3	202.8	1.0498 at 0°
p-Cresol	36	201.8	1.0522 at 0°
Olseo (b)			
Phenol	42.5 to 43	182.6	1.0677 at 35°
o-Cresol	30	191	1.0511 at 35°
m-Cresol	3 to 4	202	1.0390 at 35°
p-Cresol	36	202	1.0390 at 35°
Landolt-Börnstein (c)			
Phenol	42.5 to 43	181.5	1.0489 at 50°/4°
o-Cresol	30	187.5 to 188	1.0427 at 23°/4°
m-Cresol	About 4	200.5	1.035 at 13.6°/4°
p-Cresol	36	201.1	1.034 at 17.7°/4°

(a) Beilstein, "Hand. d. org. Chem.," 3rd Ed., 1893.
(b) Olsen, "Chem. Annual," 3rd Ed., 1913.
(c) Landolt-Börnstein, "Phys. Chem. Tab.," 4th Ed., 1912.

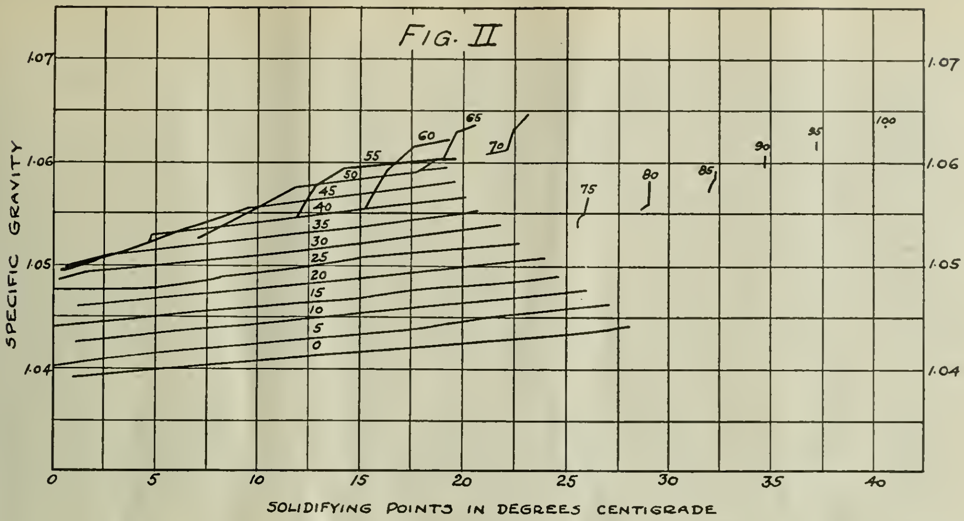
There are numerous other single references dealing with single properties of these substances but it does not seem worth while to collate them here. We have ourselves made a considerable investigation on the true solidifying point of pure phenol and find it to be 40.5° C. In this we are confirmed by Eger.[12, 13] The differences in the literature are probably due to early tests being made on small samples by the capillary tube method which might give higher figures than our solidifying point tests taken on a much larger bulk of material. It is also probable that some of the other melting points given are taken on the same basis, although we have not investigated them to the same degree as we have in the case of phenol. A comparison of our method for solidifying point (see later) with the ordinary capillary tube melting point will indicate clearly how such differences might arise.

Experimental.

The authors have attempted to give the experi-

---

[12] Pharm.-Ztg. **1903**, 210.
[13] Chem.-Ztg. Rep., **1903**, 86.



mental work in chronological order, inserting from time to time the conclusions drawn. We have not attempted to give all the details of manipulation in the single experiments, but have collected these together at the end in a description of the method. We wish to express at this point our appreciation of the work of H. E. Lloyd and C. J. Downey, who performed most of the laboratory work in connection with the problem.

A—Materials Used for Standard Mixtures.

(1) *Phenol* was prepared in the plant and represented a close cut middle fraction from the final distillation of synthetic phenol. It did not require further purification by the laboratory.

(2) *Ortho-Cresol*—We selected from a works run an *o*-cresol fraction of high purity, but containing some neutral oil and naphthalene. It was dissolved in caustic soda solution, the carbolate freed from neutral hydrocarbons by steam distillation and the cresol precipitated again by dilute sulfuric acid. The liberated cresol was separated and fractioned through a 3-bulb LeBel-Henninger column, cutting so as to give a cresol of a boiling point of about 2° C.

(3) *Meta-Para-Cresol* was prepared in the same way as the *ortho*-cresol from another fraction obtained similarly. The final material was shown by the Raschig nitration test to contain 49.3 per cent. *meta*-cresol and 50.7 per cent. *para*-cresol.

The three materials as finally used in the mixtures showed the constants given in Table III.

TABLE III.

	Solidification Point	Specific Gravity at 25° C./25° C.	Boiling Point Range
Phenol	40.4° C.	1.0636(a)	180-182° C.
o-Cresol	29.0° C.	1.0144	189-191° C.
m-p-Cresol	Below 0° C.	1.0339	199-201° C.

(a) Taken at 45°/45°C.

B—Mixture of Pure Materials.

Twenty-one so-called series were made up, using from 0 to 100 per cent. of phenol, each series representing a 5 per cent. phenol increment. In the series themselves the relative proportions of the *o*-cresol and the *m-p*-cresol were varied for every even 5 per cent. This involved making and testing a total of 231 mixtures.

The mixtures were made up by weight and the accuracy of the weighings was such as to make a maximum possible error in the final percentage of the material in the mixture of not over ± 0.2 per cent. Proper precautions were taken to prevent absorption of water both in making up the mixtures and in subsequent handling of them. The mixtures were then subjected to various physical tests as described below.

(1) *Bulb Distillation*—The first few mixtures were submitted to this test, but it was soon found that sufficiently concordant results could not be obtained. It was necessary to have accurate readings of percentages distilled every even degree in order to differentiate between mixtures made over such a close range as these were. There were so many factors, such as barometric pressure, emergent stem corrections, thermometer lag, rate of distillation, effect of air currents, etc., any of which could produce an error as great or nearly as great as 1° C., that the authors decided it to be utterly impractical to use boiling point ranges as a method of differentiation. After a number of tests had indicated the hopelessness of this method of attack it was definitely abandoned.

(2) *Refractive Indices*—A few preliminary tests on the components of the mixtures showed definitely that their constants were too close to enable us to determine at all accurately the character of a mixture by this means.

(3) *Specific Gravity*—This test proved very useful and was adopted for general use. The details of carrying out this test will be given later in connection with the described testing method. It was found desirable

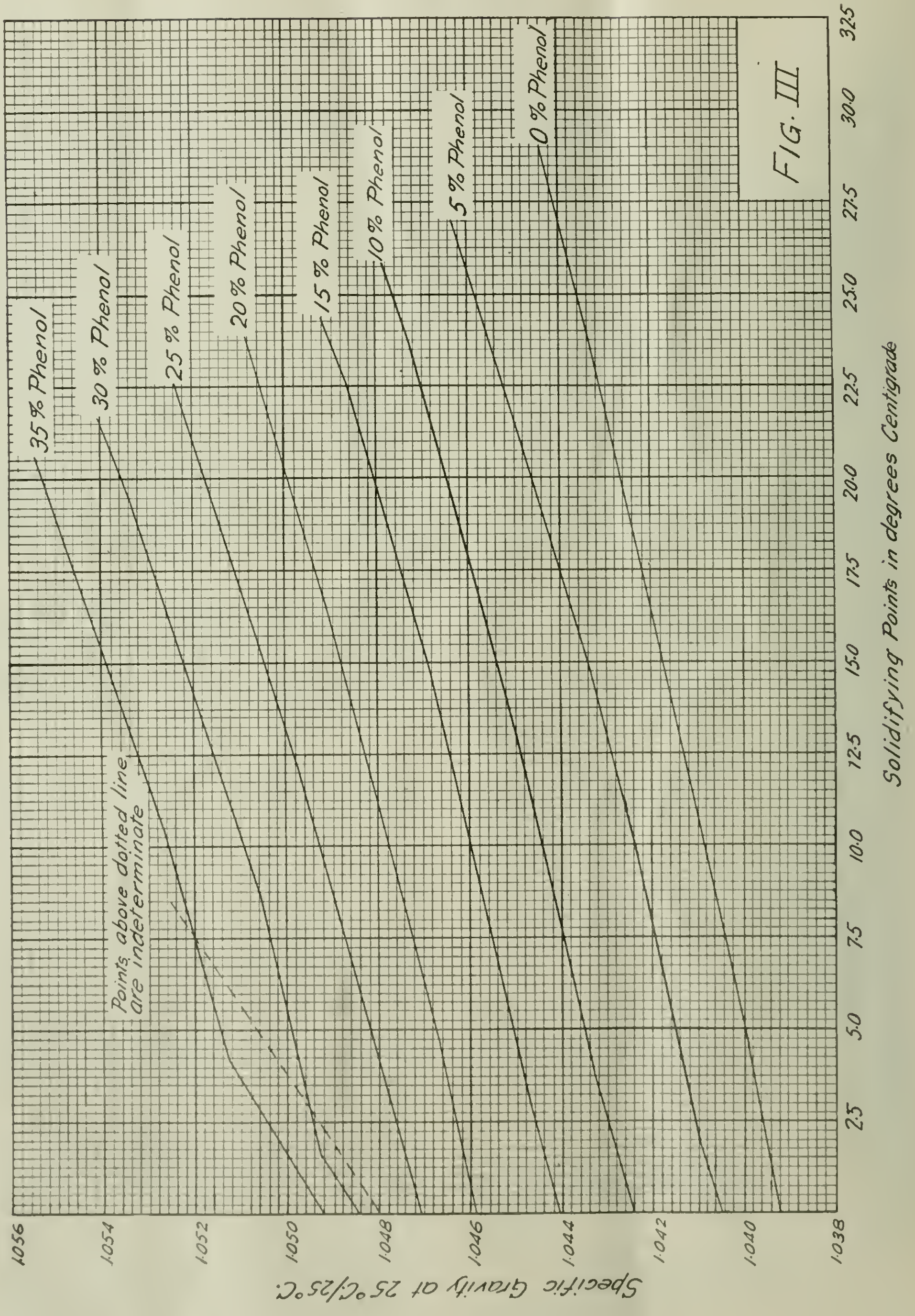


FIG. III
0 % Phenol
5 % Phenol
10 % Phenol
15 % Phenol
20 % Phenol
25 % Phenol
30 % Phenol
35 % Phenol
Points above dotted line are indeterminate
Solidifying Points in degrees Centigrade
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
27.5
30.0
32.5
Specific Gravity at 25°C./25°C.
1.056
1.054
1.052
1.050
1.048
1.046
1.044
1.042
1.040
1.038

Table IV—Tests of Phenol-Cresol Mixtures: Phenol Varied from 0 to 100 Per cent of Mixture

Phenol	o-Cresol	m-p-Cresol	Sp. Gr. 25/25° C.	Solidification Point, ° C.	Ref. Ind. 50° C.
Series 1					
0	0	100	1.0339	Below —7	1.5281
0	5	95	1.0344	Below —7	1.5281
0	10	90	1.0349	Below —7	1.5281
0	15	85	1.0354	Below —7	1.5290
0	20	80	1.0359	Below —7	1.5290
0	25	75	1.0364	Below —7	1.5290
0	30	70	1.0369	Below —7	1.5291
0	35	65	1.0374	Below —7	1.5294
0	40	60	1.0379	—5.0	1.5299
0	45	55	1.0384	—3.0	1.5299
0	50	50	1.0394	1.0	1.5300
0	55	45	1.0399	4.5	1.5298
0	60	40	1.0404	7.2	1.5303
0	65	35	1.0409	10.1	1.5305
0	70	30	1.0414	12.8	1.5305
0	75	25	1.0419	15.8	1.5310
0	80	20	1.0424	18.5	1.5312
0	85	15	1.0429	21.5	1.5312
0	90	10	1.0434	23.9	1.5319
0	95	5	1.0439	26.0	1.5311
0	100	0	1.0444	29.0	1.5310
Series 2					
5	0	95	1.0347	Below —7	....
5	5	90	1.0352	Below —7	....
5	10	85	1.0357	Below —7	....
5	15	80	1.0363	Below —7	....
5	20	75	1.0370	Below —7	....
5	25	70	1.0377	Below —7	....
5	30	65	1.0384	Below —7	....
5	35	60	1.0391	Below —7	....
5	40	55	1.0397	—4	....
5	45	50	1.0403	0	....
5	50	45	1.0410	2.0	....
5	55	40	1.0416	5.3	....
5	60	35	1.0421	8.3	....
5	65	30	1.0427	11.2	....
5	70	25	1.0433	14.4	....
5	75	20	1.0440	17.4	....
5	80	15	1.0447	19.4	....
5	85	10	1.0453	22.4	....
5	90	5	1.0458	24.7	....
5	95	0	1.0464	27.0	....

Phenol	o-Cresol	m-p-Cresol	Sp. Gr. 25/25° C.	Solidification Point, ° C.
Series 3				
10	0	90	1.0374	Below —7
10	5	85	1.0380	Below —7
10	10	80	1.0388	Below —7
10	15	75	1.0394	Below —7
10	20	70	1.0399	Below —7
10	25	65	1.0405	Below —7
10	30	60	1.0410	Below —7
10	35	55	1.0415	—4
10	40	50	1.0421	—2
10	45	45	1.0427	1.2
10	50	40	1.0433	3.8
10	55	35	1.0438	7.2
10	60	30	1.0444	10.0
10	65	25	1.0450	12.8
10	70	20	1.0456	15.8
10	75	15	1.0462	18.2
10	80	10	1.0467	21.0
10	85	5	1.0473	23.6
10	90	0	1.0479	25.8
Series 4				
15	0	85	1.0393	Below —7
15	5	80	1.0399	Below —7
15	10	75	1.0405	Below —7
15	15	70	1.0411	Below —7
15	20	65	1.0417	Below —7
15	25	60	1.0423	Below —7
15	30	55	1.0429	—6.5
15	35	50	1.0435	—4
15	40	45	1.0441	0
15	45	40	1.0447	2.9
15	50	35	1.0453	6.2
15	55	30	1.0459	9.0
15	60	25	1.0463	11.7
15	65	20	1.0469	14.8
15	70	15	1.0475	17.3
15	75	10	1.0481	19.9
15	80	5	1.0487	22.6
15	85	0	1.0493	24.4

Phenol	o-Cresol	m-p-Cresol	Sp. Gr. 25/25° C.	Solidification Point, ° C.
Series 5				
20	0	80	1.0414	Below —7
20	5	75	1.0420	Below —7
20	10	70	1.0426	Below —7
20	15	65	1.0433	Below —7
20	20	60	1.0438	Below —7
20	25	55	1.0443	—5
20	30	50	1.0448	—3
20	35	45	1.0454	—2
20	40	40	1.0461	1.2
20	45	35	1.0467	4.6
20	50	30	1.0473	7.8
20	55	25	1.0479	10.4
20	60	20	1.0485	13.4
20	65	15	1.0491	16.2
20	70	10	1.0498	18.8
20	75	5	1.0504	20.8
20	80	0	1.0509	23.8
Series 6				
25	0	75	1.0428	Below —7
25	5	70	1.0435	Below —7
25	10	65	1.0442	Below —7
25	15	60	1.0449	Below —7
25	20	55	1.0455	—5
25	25	50	1.0462	—3
25	30	45	1.0469	—2
25	35	40	1.0476	0
25	40	35	1.0480	4.8
25	45	30	1.0483	6.6
25	50	25	1.0490	8.4
25	55	20	1.0498	12.2
25	60	15	1.0508	14.9
25	65	10	1.0512	17.7
25	70	5	1.0517	20.2
25	75	0	1.0524	22.6

Series 7				
30	0	70	1.0448	Below —7
30	5	65	1.0454	Below —7
30	10	60	1.0461	Below —7
30	15	55	1.0467	—4
30	20	50	1.0473	—3
30	25	45	1.0479	—1
30	30	40	1.0486	0.3
30	35	35	1.0493	1.6
30	40	30	1.0500	5.0
30	45	25	1.0506	8.7
30	50	20	1.0513	11.6
30	55	15	1.0520	14.2
30	60	10	1.0527	16.8
30	65	5	1.0534	19.3
30	70	0	1.0541	21.7
Series 8				
35	0	65	1.0466	Below—7
35	5	60	1.0473	—4
35	10	55	1.0480	—1
35	15	50	1.0486	0.5
35	20	45	1.0493	0.2
35	25	40	1.0500	1.4
35	30	35	1.0506	3.0
35	35	30	1.0513	4.2
35	40	25	1.0520	7.4
35	45	20	1.0527	10.4
35	50	15	1.0534	13.2
35	55	10	1.0541	15.8
35	60	5	1.0548	18.2
35	65	0	1.0555	20.6
Series 9				
40	0	60	1.0487	—1
40	5	55	1.0493	0
40	10	50	1.0500	0.8
40	15	45	1.0507	2.4
40	20	40	1.0514	3.4
40	25	35	1.0521	4.6
40	30	30	1.0528	4.8
40	35	25	1.0535	6.9
40	40	20	1.0542	9.8
40	45	15	1.0549	12.4
40	50	10	1.0555	15.1
40	55	5	1.0561	17.6
40	60	0	1.0567	20.0

Series 10				
45	0	55	1.0507	3.4
45	5	50	1.0514	3.6
45	10	45	1.0521	4.7
45	15	40	1.0528	5.6
45	20	35	1.0534	6.2
45	25	30	1.0541	7.4
45	30	25	1.0548	8.5
45	35	20	1.0555	9.4
45	40	15	1.0562	12.2
45	45	10	1.0569	14.6
45	50	5	1.0576	17.2
45	55	0	1.0583	19.6
Series 11				
50	0	50	1.0527	7.1
50	5	45	1.0534	7.9
50	10	40	1.0541	8.6
50	15	35	1.0548	9.1
50	20	30	1.0555	9.8
50	25	25	1.0562	10.3
50	30	20	1.0569	11.2
50	35	15	1.0575	11.7
50	40	10	1.0583	14.4
50	45	5	1.0589	17.0
50	50	0	1.0596	19.2
Series 12				
55	0	45	1.0546	11.5
55	5	40	1.0553	11.9
55	10	35	1.0560	12.2
55	15	30	1.0567	12.4
55	20	25	1.0574	12.7
55	25	20	1.0580	12.9
55	30	15	1.0587	13.6
55	35	10	1.0594	14.2
55	40	5	1.0599	16.6
55	45	0	1.0605	19.2
Series 13				
60	0	40	1.0565	15.2
60	5	35	1.0574	15.6
60	10	30	1.0581	15.8
60	15	25	1.0585	16.0
60	20	20	1.0592	16.2
60	25	15	1.0598	16.4
60	30	10	1.0606	17.0
60	35	5	1.0615	17.4
60	40	0	1.0621	19.2

			Specific Gravity		
			25/25° C.(a)	45/45° C.(b)	
Series 14					
65	0	35	1.0590	....	17.6
65	5	30	1.0595	....	18.0
65	10	25	1.0604	....	18.6
65	15	20	1.0608	....	19.1
65	20	15	1.0617	....	19.2
65	25	10	1.0622	....	19.4
65	30	5	1.0630	....	19.6
65	35	0	1.0636	....	20.4
Series 15					
70	0	30	1.0608	1.0520	22.0
70	5	25	1.0614	1.0525	22.2
70	10	20	1.0623	1.0530	22.4
70	15	15	1.0632	1.0533	22.5
70	20	10	1.0638	1.0540	22.6
70	25	5	1.0644	1.0547	22.8
70	30	0	1.0650	1.0554	23.2
Series 16					
75	0	25	....	1.0536	25.4
75	5	20	....	1.0542	25.4
75	10	15	....	1.0547	25.6
75	15	10	....	1.0553	25.8
75	20	5	....	1.0560	25.9
75	25	0	....	1.0566	26.0
Series 17					
80	0	20	....	1.0556	28.6
80	5	15	....	1.0563	29.0
80	10	10	....	1.0570	29.0
80	15	5	....	1.0576	29.0
80	20	0	....	1.0583	29.0
Series 18					
85	0	15	....	1.0572	31.8
85	5	10	....	1.0579	32.0
85	10	5	....	1.0587	32.2
85	15	0	....	1.0594	32.2
Series 19					
90	0	10	....	1.0596	34.6
90	5	5	....	1.0603	34.6
90	10	0	....	1.0607	34.6
Series 20					
95	0	5	....	1.0617	37.2
95	5	0	....	1.0623	37.2
Series 21					
100	0	0	....	1.0636	40.4

(a) The values for the specific gravity given in this column are plotted on Fig. IV.

(b) These values are plotted on Fig. II because if plotted at 45/45° C, the curve for 70 per cent phenol would interfere with the other curves in this figure.

to use two standard temperatures. The mixtures having a solidifying point less than 25° C. were taken at 25° C. compared to water at 25° C. Above this point the specific gravities were taken at 45° C. compared with water at 45° C. Occasionally a mixture test will be found where the solidifying point is 25° C. or a trifle higher and still the specific gravities given as of 25° C.—for all these cases the specific gravity was never taken in the solid state or by correction from a higher temperature, but represents an actual determination in the supercooled liquid.

(4) *Solidifying Point*—The old method used ordinarily for phenol, in which the thermometer is used as the stirring rod in the test tube, was given a thorough trial and proved to be too inaccurate, in so far as checks by different operators were concerned, to be used for the present purposes. Accordingly a modified method was devised, the details of which are given later under the testing method. This modification of the method was used throughout the work presented in this paper.

(5) *Detailed Tests*—These are shown in Table IV. The curves in Figs. II, III and IV bring out graphically important features of these tests.

(6) *Consideration of Results*—In Fig. II there are plotted curves of all mixtures, where the solidifying point is above 0° C., using the solidifying points as ordinates and the specific gravities as abscissas and plotting a curve for each 5 per cent. of phenol. It is evident from an examination of the detailed results in the tables that if a solidifying point of a mixture is indeterminate, that is, below 0° C., that the specific gravity alone is not sufficient data for an exact determination. Therefore, for determination of phenol by this method it is first necessary to concentrate the phenol into a fraction containing only phenol and cresols of such a nature that the solidifying point is above 0° C.

It will be further noted in Fig. II that, from 0 to 30 per cent. of phenol, the curves are well separated and the constants of a mixture will serve for exact quantitative determination. From 30 to 70 per cent. phenol, the curves cross each other irregularly and points in this area are indeterminate and, therefore, not susceptible of exact determination. From 70 to 100 per cent. phenol the curves are well separated and this area can be considered as determinate. The two determinate areas are shown on a larger scale in Figs. III and IV. It is, therefore, evident that to determine phenol, it will be necessary to bring it into a fraction containing only phenol and cresols of such composition that its physical constants will plot to a point within one or the other of the determinate areas shown. The first portion of the remaining problem was, therefore, to develop a method of fractional distillation which would separate all the phenol from a crude acid with only cresols as an impurity. It is evident that with such a fraction, if its constants do not throw it into the determinate area, that a mixture of the fraction with a known amount of *pure phenol* can be made, which mixtures can

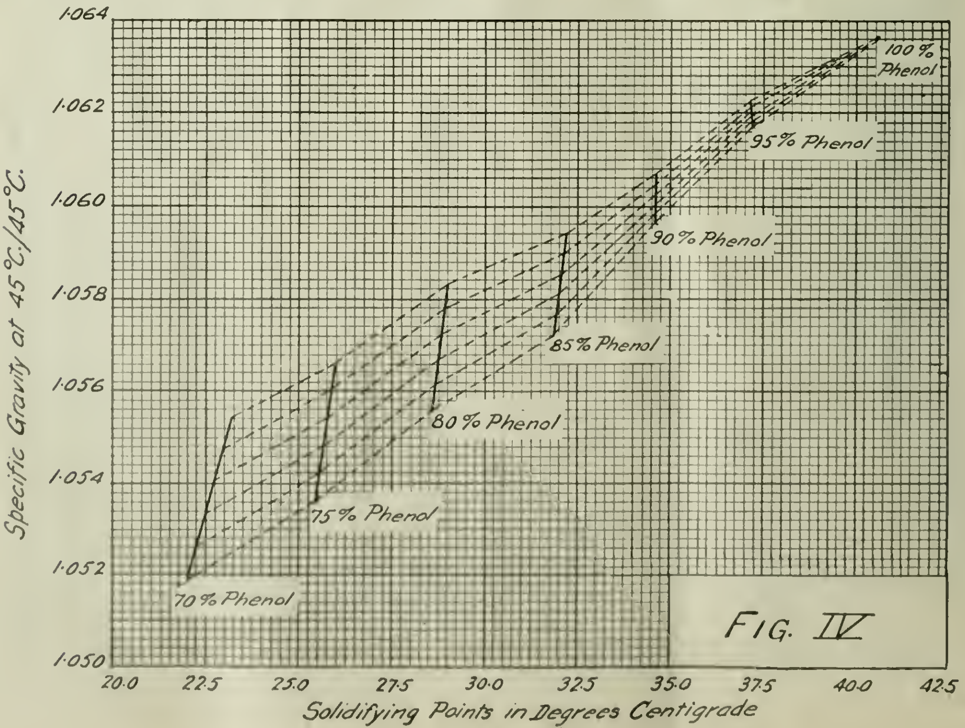


FIG. IV

be made to fall in one of the determinate areas. The percentage of phenol can be readily determined in the mixture and from the knowledge of the amount of phenol added, the percentage of phenol in the original fraction can be readily deduced. With this then as a basis, work was commenced on known mixtures of phenol, cresols, higher acids and oils to perfect the manipulative details necessary to bring phenol, no matter what its form, quantitatively into a fraction in which it was accompanied by cresols alone.

C—Work on Known Mixtures to Perfect the Details of the Method.

The preliminary tests involved a comparison of the Hempel and the LeBel-Henninger fractioning tubes. The Hempel tube was of the standard Barrett type (A. H. T. Cat. No. 20496) and the LeBel, the 3-bulb variety: 6-bulb LeBels were tried, but those obtainable were not of sufficiently good workmanship to withstand the required temperature without cracking. For these preliminary tests it was necessary to prepare some phenol-free acids of a boiling point above cresols. This was done by taking ordinary crude acids, removing the oil and naphthalene, and fractioning, taking for use the fraction distilling above 200° C. It was shown by careful test to be free of phenol. In these preliminary tests the acids (free of oil and naphthalene) were fractioned and cut at 190 and 202°. The 190-202° fraction was redistilled and cut at 197° C. The total fraction below 197° C. was compared with the curves and the phenol content estimated. If necessary, a suitable mixture was made with pure phenol so as to bring the mixture into the determinative range. Needless to say, all details of the distillation were gravimetrically quantitative.

Tests 1 to 7 may be tabulated as follows:

Test No.	Mixture—Percentages Phenol	o-Cresol	m-p-Cresol	Per cent Higher Acids	Per cent Phenol Recovered	Error in Per cent of Phenol Present
1	33.3	....	....	66.7	32.2	—3.3
2(a)	20.0	20.0	26.0	40.0	16.0	—20.0
3	20.0	20.0	20.0	40 0	19.2	—4.0
4	10.0	15.0	15.0	60.0	10.4	+4.0
5	50.0	10.0	10.0	30.0	48.0	—4.0
6	25.0	25.0	25.0	25.0	24.2	—3.2
7	30.0	5.0	5.0	60.0	29.5	—1.7

(a) In this test the Hempel column waa used, in all others the LeBel was used.

After these tests we decided to abandon the Hempel distillation for this purpose and until otherwise noted all tests were run using the LeBel 3-bulb column. A comparison of the bulb distillation of the "to 197°" fraction of Tests 2 and 3 shows why Test 2 was so much further off than Test 3.

BULB DISTILLATIONS OF TESTS 2 AND 3.

	187°	190°	195°	200°	Dry at
Test 2	2	22	81	91	205° C.
Test 3	1	47	90	98	203°.C.

The Hempel had not removed xylenols as well as had the LeBel. The effect of xylenols would be to lower the specific gravity without proportionally lowering the solidifying point, thus giving a lower phenol indication than the truth. This is true to a lesser degree in the LeBel tests and is doubtless the cause of the somewhat low results obtained in a number of the tests. In fact, on Tests 1 to 7, the only ones where bulb distillations were made on the "to 197°" fraction, all showed some residue above 201° C. It has not been thought worth while to record these distillations in detail, as all the essential information is given in the two already shown.

At this point of the investigation we decided that the fractioning method was fairly accurate, though not entirely satisfactory. It was considered advisable now to proceed to oil mixtures to determine the points in this phase of the investigation which required our attention.

Test 8—For this test we prepared a quantity of acid-free oil by completely extracting ordinary creosote oil with caustic soda. A mixture was made by using 85 per cent. of this oil and 15 per cent. of acids containing 20 per cent. phenol. The acids were extracted by caustic soda solution from a portion of this mixture. The carbolate was steam-distilled to remove neutral oils and naphthalene, the acids liberated by dilute sulfuric acid and carefully separated from the sodium sulfate layer. The test was then carried on in the usual way, taking care to separate all water from the "to 197°" fraction

The phenol recovered showed an error amounting to -20 per cent. of the phenol present.

Test 9—Here we used 80 per cent. of oil and 20 per cent. of acids containing 20 per cent. of phenol. The carbolate was formed as in Test 8, and washed with 600 cc. of benzol in three 200-cc. portions. The united benzol washings were agitated with 100 cc. of water in two 50 cc. portions. These were added to the carbolate, which was then boiled gently to expel any benzol present. The sulfate liquor, after acidification, was not washed for recovery of acids.

The general method of fractioning, which was adhered to except where otherwise noted, was to distil to 170°, separate acids from water in the distillate and return the former to the distilling flask. Fractions were then taken to 190° C. The second fraction was redistilled collecting to 197° C. and combining all acid distillates up to 197° for test. The recovery of phenol showed a loss of 22.1 per cent. of the phenol present.

Test 10—In this test no change was made in the relative proportions of the acids and neutral oil. The carbolate was steam-distilled. The NaOH solution was added in three 210-cc. portions. The sulfate liquor was washed with 150 cc. of benzol in three 50-cc. portions and these washings were added to the liberated acids. The mixture used was the same as in Test 9. The error amounted to a loss of 21.7 per cent. of the phenol.

The residual acids after fractionation were combined and tested for phenol, but none was found. In this test the benzol was separated from the acids in the fractionation. The benzol recovered had an acid odor, but only a trace of acids could be recovered by solution in NaOH.

The results of Tests 9 and 10 showed that the tar oils and naphthalene in the carbolate may be removed with benzol, instead of steam distillation.

Test 11—In this test the acid-oil mixture was approximately the same as in the previous tests. The method of procedure was the same as in the previous test, except that the liberated acids were washed with 200 cc. of a saturated NaCl solution for removal of sulfate liquor. The solidifying point of the acid mixture made on fractionation of the acids was so low that no further data were taken.

Test 12—This test in conjunction with Test 14 was made in order to determine the loss due to solution of acids in the sulfate liquor. In the light of further tests, however, it does not indicate much. This is due to other greater losses which had not been discovered at this time. No neutral oil was used in the mixture.

The carbolate was formed using 125 per cent. of the theoretical NaOH necessary. The acids were liberated with 50 per cent. H_2SO_4. The sulfate liquor was washed with 150 cc. benzol in 50-cc. portions and the recovered acids fractionated. An acid containing 20 per cent. of the phenol was taken. The error amounted to -8.5 per cent. of the phenol present.

Test 13—In this test the new modifications were the weakening of the H_2SO_4 to 33⅓ per cent. and the washing of the extracted oil with an additional 100 cc. of NaOH solution (making a total of 140 per cent.). Benzol was used to wash the carbolate. The sulfate liquor was agitated with 125 cc. of benzol and the washings added to the main quantity of acids. The acids were fractionated in the LeBel-Henninger column. The same mixture was used as in Test 12. The error found was -13.2 per cent. of the phenol present.

Test 14 was made in order to compare the loss of phenol with the loss in Test 12, where a carbolate was made and the acids liberated. The mixture contained no oil and was simply fractionated in the LeBel column. Here the error was -8 per cent. of the phenol present.

The results of this test would indicate that the loss in recovery from a carbolate was not much.

Test 15 was made in order to check the curve with a mixture containing 20 per cent. of phenol.

Mixture No. 1	Pure Phenol	20.15 g.
	Pure o-Cresol	40.05 g.
	Pure *m-p*-Cresol	40.05 g.
Mixture No. 2	Pure Phenol	75.00 g.
	Mixture No. 1	25.00 g.
Solidification Point of Mixture No. 2		28.8° C.
Specific Gravity (15/15 C.) of Mixture No. 2		1.057
Phenol in Mixture No. 2		80%
Phenol in Mixture No. 1		20%

This shows the curves to be correct at this point.

Test 16—In view of the results of tests to this point it was thought that a considerable part of our losses was due to fractionation and that a change in the temperature at which the fractions were cut might help in the phenol recovery. Accordingly a mixture of acids was made and fractionated using the LeBel-Henninger column as in previous tests. The first fraction collected was to 190° C., the second between 190 and 205° C. This second fraction was redistilled until a temperature of 198° C. was reached. The first and redistilled fractions were collected in the same flask as in previous test. Using the usual 20 per cent. phenol acid, an error of -16.5 per cent. of the phenol present was obtained.

Test 17—In this test the temperature of fractionation was again changed. The first fraction collected was that coming over to 190° C.; the second between 190 and 204° C. This fraction was redistilled up to 195° C. With the same mixture as in Test 16 we showed an error of −10.1 per cent. of the phenol present.

Changing the temperature of fractionation did not increase the amount of phenol recovered. We then concluded that the column used in fractionation should be changed.

Test 18—We then decided to try the 12-pear column. To determine the efficiency of this apparatus as a fractioning device, we made a mixture of pure acids as in previous tests, and fractionated the mixture using the original temperature, *i. e.*, to 190° C. (190-202° C.) and redistillation to 197° C. The error here amounted to only +1.4 per cent. of the phenol present.

Results of this test showed that the losses due to faulty fractionation had been overcome. From this point on, our tests were made with a view to overcoming the losses which occur on formation of carbolate and subsequent liberation of the acids. This involved the proper strength and amount of H_2SO_4, the temperature of acidification, the washing of carbolate and recovery of the acids dissolved in the sulphate liquors.

Test 19—In this test we attempted to recover all of the phenol in a pure acid mixture after converting the acids to a carbolate. The acids were agitated with 125 per cent. of the theoretical amount of NaOH necessary. The acids were then liberated with 25 per cent. solution of H_2SO_4, using a very slight excess of acid (about 10 cc.). The sulphate liquor was washed with 100 cc. of ether in two 50-cc. portions and the washings added to the main quantity of acids. The acids were then fractionated with the 12-pear column. It was impossible to make a clear separation of the ether and acid distillates. The ether and water that came over were agitated with an NaOH solution and the acids recovered. They amounted to about 4 cc. However, they were not added to the acid distillate and so were lost. Better results were obtained here by reducing the strength of the sulphuric acid to 25 per cent. There was a cleaner separation, the acids were lighter colored and there was no gas formation. The error here was −2.1 per cent. of the phenol present.

The results of this test indicated that the phenol in a mixture of pure acids could be recovered substantially quantitatively from a carbolate.

Test 20—In this case 150 per cent. of the theoretical quantity of NaOH was used to form the carbolate. The sulphate liquors were washed with benzol. Any acid was recovered from the benzol by washing with caustic soda as described previously. This acid was added to the main bulk of acids. The recovery of phenol showed a very low error, only 0.2 per cent. of that present.

Test 21 was made using a mixture of 20 per cent. of pure phenol with crude cresols and higher acids, instead of the purified acids, as in Tests 19 and 20. 125 per cent. of the theoretical amount of NaOH was used. The carbolate was washed with 500 cc. benzol in 125-cc. portions. The acids were recovered from the sulphate liquor as in Test 20. The error was −1.3 per cent. of the phenol present.

Test 22 was a check on Test 20, the same procedure being used in each test. The error here was −0.8 per cent. of the phenol present.

After running Tests 20, 21 and 22, we concluded that the phenol present in a mixture of acids with small amounts of oil could be recovered with but slight loss. Our next attempt was to recover the phenol from an acid-oil mixture which contained a large amount of neutral oil.

Test 23—In this test we added enough neutral oil to the acids to make it 80 per cent. of the total mixture and attempted to recover the phenol. The acids were extracted from the mixture with 150 per cent. of the theoretical amount of a 20 per cent. NaOH solution: 800 cc. of the NaOH solution were used in three 200-cc. and two 100-cc. portions. The carbolate was washed with 500 cc. of benzol in 100-cc. portions. The sulphate liquor was washed with ether, and the dissolved acids recovered from ethereal solution with a weak NaOH solution and added, after liberating with H_2SO_4, to the main quantity; 9.2 grams were recovered. This method of recovery and separation from the solvent is a new and important step in the process. The acids were fractionated as before.

Acid-Oil Mixture	Phenol	59.85 grams 20%	20 per cent
	o-Cresol	59.80 grams 20%	
	m-*p*-Cresol	59.80 grams 20%	
	Higher Acids	119.30 grams 40%	
Neutral Oil		1212.50	80 per cent

In the above mixture the acids, with the exception of the phenol, were crude.

The loss of phenol in this test (*Nvf p*er cent. of the phenol present) was very high (due to imperfect technique, as will be seen later), and it was decided to make tests using smaller quantities of neutral oil.

From this point on, the general method of recovery of the acids was the same, *i. e.*, formation of a carbolate with NaOH (20 per cent. strength), washing of the carbolate with pure benzol, washing the benzol solution of carbolate with water, boiling of the carbolate, liberation of the acids with 25 per cent. H_2SO_4, washing the sulphate liquors with benzol and recovery of the dissolved acid with weak (10 per cent.) solution of NaOH. All fractionations were made with the pear column.

The essential results of Tests 24 to 35 inclusive are shown in the following table:

Test No.	Grams Phenol	Grams *o*-Cresol	Grams *m*-*p*-Cresol	Grams Higher Acids	Grams Oil	Grams Phenol Recovered	Error in % Phenol Present
24	59.75	60.00	60.35	119.90	101.75	55.83	—6.6
25	59.20	59.75	59.85	119.70	10.10	58.08	—1.8
26	60.00	60.10	60.00	119.60	10.30	63.10	+5.1
27	60.00	59.61	59.70	119.10	30.00	60.08	+0.13
28	58.55	60.00	59.60	119.70	120.00	58.10	—0.8
29	29.56	70.00	70.00	129.30	......	31.20	+5.2
30	29.40	70.30	69.70	129.30	......	29.80	+1.6
31	14.65	75.00	74.80	134.70	......	14.05	—4.1
32	15.05	76.00	74.80	135.15	......	15.90	+7.0
33	88.55	44.90	45.10	119.70	......	82.30	—7.0
34	149.90	30.05	29.65	90.15	......	149.20	—0.5
35	**15.05**	74.85	75.50	134.80	1200.00	14.73	—2.1

In Test 33 a known loss occurred in manipulation, so that this result is natural. The tests seemed to us to be accurate enough for all practical purposes, and checks should be obtained to 0.8 gram of phenol if the work is carried on carefully and conscientiously.

Up to this point we had succeeded in the recovery of the phenol from its mixtures with other pure acids, with unpurified acids in varying portions, and with neutral oil in varying proportions.

To determine the reliability of the test, when applied to crude carbolic acid, we first determined the percentage of phenol in a sample of ordinary crude acids, and next in these acids to which we had added a known amount of pure phenol.

Test 36—*Determination of the phenol in ordinary crude carbolic acid:* The acids contained 5.32 per cent. (by weight) of water and had a specific gravity at 15.5° C. of 1.072.

We first tried to wash a carbolate made with the crude acids as obtained, but there was not a clean separation of the benzol and carbolate layers. We found it necessary to distil the acids first. The crude acids were distilled, after weighing, directly into a 2000 cc. separatory funnel.

Weight of acids distilled........................	301.5 grams
Weight of distillate (by difference)..........	271.3 grams—90 per cent
Black pitch residue..............................	30.2 grams

The carbolate was now formed as in previous tests, and washed with benzol. The recovery of the acids and the fractionation were carried out as in the previous tests. We found the phenol content by weight to be 16 per cent. on the dry acids or 15.14 per cent. on the wet acids.

Test 37—In this test we added a known amount of pure phenol to the crude acids tested above.

Crude acids....................	301.15 grams
Pure phenol added...........	15.85 grams

On determination of the phenol we found that of the phenol added we had recovered 99.2 per cent.

The better results in the later tests were due to constant improvments in the technique with experience. In the following description, we believe, we have given that technique with sufficient wealth of detail to enable any operator following directions carefully, to obtain consistent, accurate results.

D—Standard Method for Determination of Phenol in Crude Carbolic Acid and Tar Oils.

I. Preface—In this test extreme care and faithful attention to details are necessary to secure accurate results. All instructions given are the epitomized result of considerable experience and are not given arbitrarily, but with a purpose. The test has been a difficult one to develop and requires greater care and skill than do the ordinary tar-testing methods. Even a slight deviation from the directions can cause serious discrepancies.

II. Preparation of the Oil—If the oil is at all dirty, so that the subsequent separation of the carbolate will not be clean, it must be distilled. This shall be accomplished by weighing a suitable quantity of oil into a clean copper tar-still and taking the total distillate from the start of distillation to coking. The amount of total distillate by weight shall be noted so that results may be figured back to the original oil if desirable. If any foaming-over occurs during the distillation, the run must be rejected and a new one undertaken.

III. Extraction of the Acids From the Oil—The approximate percentage of tar acids in the oil should be determined by a rough test. A weight of oil which contains between 300 and 350 g. of acids shall be placed in a separatory funnel and treated with 300 cc. (approximate) of 20 per cent. caustic soda solution; this caustic soda solution may be made from commercial caustic soda. The oil and caustic soda shall be given a thorough mixing by shaking, care being taken to prevent mechanical loss. The mass shall now be allowed to stand until the carbolate settles completely and a sharp line of division appears between the oil and the carbolate. With a properly distilled oil, from 15 to 30 minutes should suffice. If the oil contains solids, it shall be warmed before extraction to a temperature sufficient to keep solids in solution, and while settling be suspended in a bath of like temperature.

After settling is complete, the carbolate shall be separated and brought into another separatory funnel. The oil shall be washed successively with three more portions of 200 cc. each of the same caustic soda solution, observing the same precautions as to agitation, settling and separation. These separated soda solutions are to be added to the first carbolate. On the last separation it is better to run a few drops of oil along with the carbolate, rather than leave a few drops of carbolate in the oil. After this treatment the oil shall be tested to determine if it is free from tar acids and if so, it may be discarded.

Note—If crude acids, not oil, are to be tested, 300 to 350 g. of the crude acid shall be taken in a separatory funnel and dissolved in 800 cc. of 20 per cent. caustic soda solution. The treatment from this point on is the same as with carbolate extracted from oil. If the crude acids are tarry it is advisable to distil them quantitatively before dissolving them in caustic soda.

IV. Purification of the Carbolate—The carbolate in a separatory funnel shall be extracted five times successively with 100-cc. portions of pure benzol. The manipulation shall be: Add the benzol to the carbolate, mix thoroughly by shaking and allow to settle. Draw the carbolate into another separatory funnel and draw the benzol into a third separatory funnel. Repeat the agitation with fresh benzol four times more, using the two original separatory funnels for this purpose. Finally, after running the washed carbolate into a beaker, rinse each of the funnels which contained carbolate, twice, with 25 cc. each of water, and add the water to the carbolate in the beaker. Take the third separatory funnel, which contains the combined benzol, and wash twice with 50 cc. of water, adding this water also to the carbolate in the beaker. Bring the carbolate in the beaker to a gentle boil until the odor of benzol disappears. No odor of creosote shall be evident in the carbolate at this point. If such odor appears, the washing has not been properly carried out and must be repeated. The carbolate purified of oil is ready for acidification after cooling. The benzol used for extraction may be discarded.

V. Acidification—The purified carbolate shall be placed in a separatory funnel and acidified with sulphuric acid of 25 per cent. strength (sp. gr. 1.21 at 15.5° C.). The beaker containing the carbolate shall be rinsed with water and the rinsings added to the carbolate in the funnel. During acidification the mass *must* be kept *below 40° C.* by immersion in a bath of cold water. Test for acidity should be made from time to time with litmus paper. *More than a very slight excess* of acid (5 to 10 cc.) must not be added after litmus shows a red color. When acidification is complete, the funnel shall be allowed to stand until complete separation has taken place and the lower layer of sodium sulphate solution is perfectly clear or at most shows a slight opalescence. This settling requires from 3 to 4 hours. After settling is complete the sulphate layer shall be drawn off and kept for further treatment. The carefully separated acid layer shall be drawn down into a weighed 500 cc. round-bottomed short ring neck flask and kept there until further treatment.

VI. Treatment of the Sulphate Solution—This shall be returned to the separatory funnel which contained the separated tar acids, which still has a thin film of tar acids adhering to the walls. The sulphate liquor shall be extracted three times with successive portions of 100 cc. each of pure benzol and the benzol extracts combined in a separatory funnel of about 500 cc. capacity. The benzol extract shall now be extracted with two successive portions of 25 cc. each of 20 per cent. caustic soda solution, or until the soda solution separates nearly colorless. The benzol can then be discarded. The caustic soda solution shall then be warmed until all odor of benzol disappears and acidified with enough 25 per cent. sulphuric acid to make slightly acid. This shall be allowed to settle completely, the lower layer of sulphate drawn off and discarded, and the upper layer of acids added to the flask containing the main amount of the separated acid. This flask shall now be weighed and the weight of *wet* crude acids recorded.

VII. Fractional Distillation—*A. Column*—This shall be the standard 12-pear still head (Eimer & Amend catalogue No. 7156).

B. Flask—This shall be a short neck flask as described under V.

C. Condenser—This shall be the regular Barrett trough type with a 24-in. tube (A. H. T. catalogue No. 20432).

*D. Thermometer**—This shall conform to the following specifications: (1) It shall be graduated from 170 to 225° C. in 1/5° C. and shall be accurate at total immersion to 1/5° C. (2) It shall be well annealed and shall conform to the following dimensions:

Total length—less than 380 mm.
Bulb length—20-25 mm.
170° mark to bottom of bulb—70-80 mm.
Scale length 170-225°—270-280 mm.
Stem diameter—5-7 mm.
Bulb diameter—4-5.5 mm.

E. Setting Up Apparatus—The flask shall be supported over a burner on a 6-in. square of 1/4 in. asbestos board with an opening in the center 3.5 in. in diameter. It shall be surrounded by a circular asbestos shield about 3½ in. high and of such diameter as to enclose the flask. A piece of asbestos with a hole cut for the neck of the flask forms the top of the shield. The pear column shall be connected to the flask by a tight-fitting cork, and the condenser to the side tube of the pear column. The thermometer shall be inserted into the top of the pear column by means of a well-fitting cork in such manner that the top of the thermometer bulb is opposite the middle of the off-take of the column. The condenser trough shall be kept full of cold water.

---

*This thermometer can be obtained from the Taylor Instrument Co.

F. Method of Conducting the Distillation—The apparatus shall be set up as described and the distillation started and continued at the rate of one drop per second. The distillate shall be first caught in a 100-cc. separatory funnel until the temperature has reached 170° C. The distillation shall then be interrupted and sufficient salt added to the contents of the separatory funnel to cause any acids coming over with the water to rise to the surface. The aqueous layer is removed and the acids returned to the distillation flask, and the flask with contents weighed. Thereby the weight of *dry* acids is recorded. The distillation shall be again started and the first few drops of acid and water coming over collected in a small, dry separatory funnel. When the last drop of water is over, a fraction to 190° C. is collected in a weighed flask, which shall be closed by a cork as soon as the distillation is completed. The few drops of acid and water which have been collected in the small funnel shall be separated and the acid layer added to the distillate to 190° C. A second fraction from 190 to 202° shall be collected in a 250-cc. round-bottom, short ring-neck flask, which need not be weighed. The distillation shall be discontinued at 202° C. and the flask containing the 190–202° fraction shall be substituted for the first flask, which contained the crude acids. This fraction is now redistilled after drying the condenser tube, using the weighed flask containing the —190° fraction from the first distillate as a receiver. The distillation shall be carried to 197° C. The receiver which now contains the combined fraction up to 197° shall be weighed, the weight of the fraction recorded, and the receiver kept tightly stoppered.

G. Testing the Fraction—The fraction shall be tested for specific gravity and solidifying point as follows:

(1) *Solidifying Point:* A test tube 1 in. inside diameter (this dimension bears no deviation) and 5 in. to 6 in. long is held by a clamp in a vertical position with 3 in. of its lower end immersed in a 500–600-cc. beaker full of water. A standard 0–80° melting point thermometer (A. H. T. Cat. No. 20476), calibrated to an accuracy of *at least* 0.1° C., is fastened rigidly by another clamp in the center of the test tube with the bottom of the bulb 0.5 in. from the bottom of the test tube. An agitator, composed of an iron washer attached to a wire and arranged to work freely up and down the test tube around the thermometer, completes the outfit.

The fraction to be tested for solidifying point shall be poured into the tube to a depth of 2 in. and an approximate solidifying point taken. The contents of the tube shall be again liquefied and the outside bath adjusted to a temperature 4.5 to 5.5° C. below the approximate solidifying point. The temperature relation is very important. The sample is now allowed to cool with constant stirring. The temperature of the sample falls, but when crystals begin to separate a rise is noted which soon reaches a maximum where it remains constant for a varying period of time. This maximum temperature shall be taken as the solidifying point. Two successive tests must give identical results and care must be taken to keep the relation between solidifying point and bath temperature within the 4.5 to 5.5° C. range.

(2) *Specific Gravity*—If the solidifying point is 25° C. or less, this shall be taken at 25/25 C.; if greater than 25° C., the specific gravity shall be taken at 45/45° C. The specific gravities shall be taken with a Westphal balance. Most of the instruments supplied in the United States are standardized for 15.5– C. The balance is set up and the plummet should exactly counterpoise the arm when swinging freely in air. It must must be first adjusted to this condition by means of the leveling screw on the base of the column of the balance. The plummet is then immersed in freshly boiled distilled water at 1.5° C. and if the balance and weights are properly made a reading of 1,000 should be obtained. Next, a reading is taken in boiled distilled water at either 25 or 45° C., depending on the temperature desired. After the first adjustment of the balance, the reading in water at 15.5 C. may be dispensed with, but care should be taken to see that the balance in air is correct before readings are made. After the water standard at 25 or 45° C. is established, a reading is taken in the acid fraction at the same temperature. A simple division gives the specific gravity. Precautions to be observed are: keep the balance clean and dry; see that the plummet is properly cleaned and dried when changing from one liquid to another; keep the point to which the wire holding the plummet is immersed constant; control the temperature carefully; and see that the plummet swings freely and does not touch the sides of the vessel containing the liquid.

(3) *Comparison with Curves*—After the solidifying point and specific gravity of the fraction are determined, compare them with the phenol determination curves and see whether the point plotted by the constants falls well within a determination area. If it does not or if it is very close to the limit, it is best to proceed to make a mixture of the fraction with pure phenol.

(4) *Mixture with Phenol*—Phenol for this purpose must possess a solidifying point of at least 40.5° C., tested on the thoroughly dry material. A little judgment is required in making the mixture so as to use

the least amount of phenol which will bring the tests of the mixture well within one or the other of the determinate ranges. Needless to say, the mixture must be strictly quantitative, and must be made in perfectly dry containers. The mixtures are made up until one susceptible of determination is obtained. The specific gravities and solidifying points are taken exactly as described previously.

H. Interpretation of Results—After the tests show the point to be within the determinative areas the method of interpolation is as follows: If the plotted point occurs in the lower set of curves a line is drawn through the point normal to the curves between which it lies. The distance from curve to curve is measured accurately along this line and the fractional distance of the point is interpolated into per cent. phenol. If the point occurs in the upper set of curves, the line is drawn through the point parallel to the nearest of the dotted converging lines, the linear distance measured and the percentage interpolated as before.

If mixtures are made, the calculations are somewhat complicated and the following formula may be used:

Let A = per cent phenol found in mixture
B = Grams "to 197°" fraction taken
C = Grams pure phenol taken
X = per cent. phenol in "to 197°" fraction.

$$X = \frac{A(B + C) - 100\,C}{B}$$

The per cent. phenol in the "to 197°" fraction multiplied by the weight of the fraction gives the weight of total phenol in the oil or crude acid taken.

A specimen test on acid with the recorded data may be shown as follows:

Distilled 170—190°	60.65 g.	
190—202°	178.05 g.	
190—202° redistilled to 197°	78.05 g.	
Total under 197°	.138.7 g. = 46.2 per cent	
Sp. gr. at 25/25° C.		1.0602
Solidifying point		20.4°
Mixture to 197° fraction	25 g.	
Pure phenol	25 g.	
Sp. gr. at 45/45° C.		1.0576
Solodifying point		31.7° C.
Phenol in fraction mixture (from curve)		84.75 per cent
Phenol in original acids (calculated)		32.2 per cent

The method requires about two days to complete a test but several can be run simultaneously. The keynote of success in this work is extremely careful and accurate attention to the details of manipulation. This test has been in use in our laboratories since the early part of 1916, and has given very satisfactory results.

Research Department, The Barrett Company, 17 Battery Place, New York City

COAL-TAR INTERMEDIATES

Differentiation of the Two Naphthols by the Aid of Sulfotitanium.

G. Deniges (Anal. Chim. anal., 1916, 216, Annales de.fals., 1916, 90, 478) shows that a-naphthol and b-naphthol can be clearly differentiated, under certain conditions, by the sulfotitanium reagent, which has already been applied to the alkaloids. To 2-3 c.c. of the reagent in a test-tube, 1-2 centigrams of naphthol are added. On shaking, the mixture is colored intense green by a-naphthol, and blood red by b-naphthol. Dilution with acetic acid changes the first coloration to red-violet, but does not affect the second.

In another method of applying the test the same quantity of naphthol is dissolved in 10-20 drops of acetic acid, and 2-3 c.c. of the titanium reagent are carefully poured down the side of the test-tube. The reagent falls to the bottom, and at the zone of separation between the two liquids, especially if shaken gently, a green ring soon appears surmounted by a red-violet cloud, with a-naphthol, and a red ring, with the same color above, in the case of the beta compound. On thoroughly mixing the two liquids the color is distributed throughout. Naphthol ethers, such as the benzoates, react in a corresponding manner.

Manufacture of Phosgene.

Such large amounts of phosgene are now currently required for the production of Michler's ketone (resultant from the reaction of carbonyl chloride upon dimethyl-aniline) that a new method for preparing the same, recently devised by Norman L. G. Whitehouse, of Pittsburgh, Pa., possesses some interest (Amer. Pat. 1,231,226, of June 26, 1917). The essential feature is the introduction of carbon monoxide at the bottom of a cylinder containing liquid chlorine, which is maintained at a temperature of 34° C. The operation is continued until the absorption of the CO ceases. The ordinary method of preparing carbonyl chloride is to pass equal volumes of CO and Cl over a condensing surface such as animal charcoal or platinized asbestos.

Quantitative Estimation of Picric Acid.

A. A. Boon and James Ogilvie (Pharm. J., 1916, 97, 213) effect the determination of picric acid by quantitative reduction to the triamino compound. They use $TiCl_3$ and HCl, following the Knecht and Hibbert method, which gives accurate results, is sensitive, and may be applied to acid and alkaline solutions and to preparations containing camphor. The titration of picric acid with $N/2$ NaOH is limited in application.

3-Nitro-1-amino-benzene-6-sulfonic Acid.

The Bayer Co. (Ger. Pat. 294,547) describes a method for obtaining this intermediate by the action of oleum, in excess, on m-nitraniline at 120°-140° C.

Aromatic Amido-Oxy-Compounds.

O. Imray (Eng. Pat. 18,081, of 1915) describes interesting results obtained in the preparation of amido-oxy-compounds by electrolysis. In the electrolytic reduction of nitro compounds effected by a carbon cathode and by an anode of nickel, platinum, etc., more amine results as the cathode dissolves and is redeposited in a form to produce amine. Two metals in the cathode reduce action, such as Pb or Bi in the cathode itself, or a Pb cathode and Bi powder or salt added to electrolyte. Nitrobenzene, in presence of sulfuric acid, with such a cathode gives 50 per cent. p-amido-phenol (pure), and as a by-product 20 per cent. of aniline.

Amino-anthraquinone.

The Farbenfabrik vorm. F. Bayer und Co. (Ger. Pat. 295,624, of 1912) describes methods of manufacturing 2-amino-anthraquinone and various derivatives of the same. The starting point is 2-chloro-anthraquinone, or any of its derivatives which do not contain a strongly negative substituent, such as carboxyl, halogen, nitro or sulfo groups, in ortho position to the chlorine atom. The chlorine is replaced by NH_2, as the result of heating with aqueous ammonia under pressure, either with or without the aid of copper or copper salts.

An Improved Method of Separating Sulfonic Acids.

Prof. L. M. Dennis, of Cornell University, has perfected a method (Amer. Pat. 1,229,593, of June 12, 1917) for the separation of the sulfonic acids of aromatic hydrocarbons from the residual, dilute sulfuric acid at the end of the reaction. The mixture of acids is agitated thoroughly with benzene, in which the sulfonic acid is completely soluble. The resultant solution forms a supernatant layer, which is drawn off. From this solution the sulfonic acid is readily extracted by treatment with water. Hydroxides or carbonates of the various metals may be added to the aqueous solution thus obtained. and any desired salt can thus be prepared. (Prof. Dennis' recently invented method of manufacturing sulfonic acids was described fully in this journal for June, 1917, page 129.)

ARTIFICIAL COLORS

The Evolution of Coal-Tar Colors

[The editor of the English periodical, "The Dyer and Calico Printer," recently contributed to the London "Times" the following interesting historical outline of the successive features in the growth of the coal-tar color industry. It is so generally deemed to be almost entirely the product of German scientific and technical ability, that it is desirable to have brought out in bold relief the solid achievements of British and French chemists and dyers, in furthering its evolution.—Ed.]

In 1825 Faraday discovered benzene, the initial product for the production of aniline. William Henry Perkin, son of a London builder, left school in 1851 at the age of 15, and became a student under Professor A. W. Hofmann at the Royal College of Chemistry, London. Taking a keen interest in laboratory work and developing a great capacity for it, young Perkin became Hofmann's private assistant at the age of 17.

In his holiday time, in a small laboratory in his father's house, and entirely on his own initiative, he attempted the synthesis of quinine. He started with a derivative of toluidine as raw material, and as oxygen is absent in this substance and present in quinine he tried the effects of oxidation. The result was a brownish precipitate, which he showed Hofmann, who advised him to throw it away. Research chemists at this time had a strong objection to substances that would not crystallize or that were colored, and this combined these objections.

The Discovery of Mauve.

Perkin, however, continued his experiments and turned his attention to the oxidation products of aniline, so closely allied to toluidine. The result was the production of a mauve dye mixed with a much larger proportion of a black pigment. This was the famous pioneer dye mauveine, or Perkin's mauve, together with insoluble aniline black. The aniline he used was not pure; it contained toluidine. To accentuate the accidental nature of the discovery it has frequently been stated that if Perkin had not been working on impure aniline he would not have discovered the dye. This is not correct. Later he produced from pure aniline a mauve, which he called pseudo-mauveine.

The young inventor at once realized that he had produced a potential textile coloring matter of great beauty, and commenced a series of dyeing experiments. He found that it dyed silk without a mordant, but that cotton required preparation with tannin and tartar emetic. It was a basic dye, the most brilliant but least fast class of dyestuffs. Perkin next consulted Messrs. Pullar, the Perth dyers, who gave so favorable an opinion that he at once took out a patent. This was in 1856.

Greenford Green Works.

In partnership with his brother, Thomas Dix Perkin, and his father, who put most of his capital into the venture, the works at Greenford Green, near Harrow Hill, were started on a modest scale in the following year under the style of Perkin and Sons. The mauve dye was quickly in vogue with the silk dyers. British cotton dyers and calico printers objected to the high price and complained that it would not stand bleaching powder. The French textile printers took it up more readily, and when their patterns appeared in the markets all other printers had necessarily to follow suit. Mauveine was supplanted in the course of time by faster violet dyes, and its last employment in England was for the coloring of postage stamps.

With W. H. Perkin busily engaged on research and his brother energetically and capably conducting the sales department, the business prospered. Other dyes were put on the market, notably synthetic alizarin. Colin and Robiquet, Frenchmen, had in 1826 isolated the coloring principle of madder and called it alizarin, from the Levantine name of the plant, alizari. Graebe and Liebermann, Germans, first synthesized this substance by fusing dibromoanthraquinone with caustic potash, far too expensive a process to be employed commercially. The practical solution of the problem was found in substituting anthraquinone sulfonic acids for the bromine compound. Perkin, Caro, Graebe and Liebermann were all working at the same time on these lines. Perkin's work was entirely independent. On May 20, 1869, he sent samples, dyed with artificial alizarin, made with sulfonic acid, to Mr. Robert Hogg, of Glasgow. Unfortunately, he did not at once take out a patent. Graebe and Liebermann's specification is dated June 25 of the same year; that of Perkin one day later. As regards the actual manufacture, the Greenford Green works in 1870 were the sole source of supply of the artificial alizarin. Perkin eventually sold his patent rights to Brooke, Simpson and Spiller, who resold them to Burt, Bolton and Hayward. These firms were in successive occupation of the works at Greenford Green. On the expiration of the patents they passed into the hands of the British Alizarin Company, still a flourishing concern.

Perkin, it must be noted, was the first to prepare an artificial perfume from coal tar. This was coumarin, the odoriferous principle of the Tonka bean. In the researches that led to this result he discovered reactions, which have since been of essential service in the synthesis of indigo.

Other British Dye Makers.

Perkin's initiative quickly led to the evolution of a British coal-tar color industry. Before 1860 Simpson, Maule & Nicholson and Roberts, Dale & Co. were at work and prospering. By 1865 they were joined by Read Holliday & Sons, Dan Dawson, Williams, Thomas & Dower and Levinsteins. By far the greatest development took place in Germany, not from any scientific or technical superiority, but by reason of economic advantages. The founders of the German industry were not chemists, but sound men of business, with an imagination which displayed to them the possibilities of the future of the synthetic colors, and an admirable foresight which led them to reserve their profits and invest them in the business. Bismarck had not yet converted the King of Prussia into the German Emperor, and Germany was a collection of separate states. The result was that German patent law was in a state of hopeless confusion and the German manufacturers exploited British patents with impunity. British patents could not be patented in Germany with any sort of a guarantee of security and the manufacturers of the Fatherland used any English working process that they could discover, without paying anything in the shape of a royalty. Our pioneer, then Dr. Perkin, F.R.S., remarked to the writer in this connection: "We could not protect our own patents in England, much less abroad."

As an example of the clear insight of the future which was a great factor in the essential German success, take the case of alizarin. In 1870 a combine of German manufacturers of alizarin was formed, and for some years netted a clear million sterling annually from this dyestuff alone. A large portion of this huge profit was wisely devoted to building and equipping modern factories, and to the endowment of perfectly-equipped research laboratories, occupied by ample staffs of specially trained chemists. Success in research is on the side of the heavy battalions. In proportion to the number of chemists engaged, probably more important discoveries in the field of dye making have been made in England and France than in Germany.

Aniline Black.

The Rhine factories have had the lion's share of the profits from aniline oil and aniline hydrochloride, and yet the long history of the evolution of aniline black is remarkable for the absence of German names. The step-by-step progress of the art is almost entirely due to England and France. It is true that Germany can claim old-time laboratory experiments on aniline, obtained from the dry distillation of indigo, but these academic researches had been completely forgotten when Perkin obtained aniline black in powder, in commercial quantities, as a by-product of his mauve. This insoluble black was used by the calico printers as a pigment color. Crace Calvert first produced the black on the fibre and showed calico prints of it at the Exhibition of 1862. Lightfoot, an Acrington calico printer, prefected the process to such a degree, that he may be considered the veritable inventor. Lauth, a Frenchman, realized the most important improvement of Lightfoot's black. This was in 1864, and his process is still in current use. So far these were printing processes. Boboeuf, a Frenchman, took out the first patent for dyeing hanks, and his process is still largely used in the north of France. Prud'homme, a Frenchman, completely solved the problem of producing white and colored effects on aniline black. Professor A. G. Green, as lately as 1907, made the highly important discovery that the oxidation of aniline can be effected by the oxygen of the air, thus avoiding tendering.

On the mechanical side Thom, a Lancashire man, produced the first practical apparatus for steaming the dyed or printed goods, and a Salford firm improved this to such an extent, that the machine is known universally, in technical literature as the Mather and Platt.

These are the most important steps in the evolution of this black. Even in minor matters the progress of the art has been due mainly to England and France.

Retirement of W. H. Perkin.

In 1873, at the early age of 37, W. H. Perkin decided to retire from business. His father was dead, and he and his brother had realized fortunes. The reasons for the step were many. Greenford Green, in many ways, was unsuitable for dye-making. In any case, to keep abreast of competitors, the necessity of doubling or trebling the factory was realized, and the Perkins were satisfied with the profits they had accumulated and unwilling to risk them in the extension of a business which was beginning to be heavily handicapped in England. They were weary of litigation. Possibly a main reason of the decision was that Mr. W. H. Perkin's mind was turning to research in other directions, unconnected with commercial activities. He turned his house at Sudbury into a series of well-equipped private laboratories, building for himself a larger dwelling house close at hand. It will be within the remembrance of many, that as Dr. Perkin, F.R.S., he lived to celebrate the jubilee of his discovery. The scientific world joined in the celebration, and in the same year—1906—he was knighted. He died the following year.

Rapid Development of the Industry.

The coal-tar color makers have aimed at simple application in textile coloring on every description of fibre, combined with qualities of fastness suitable for every possible requirement. Direct cotton colors have been introduced capable of dyeing that most inert of textiles, cellulose, in a simple salt bath, without previous mordanting of the fibre. The sulfur colors, with the exception that they require dissolving in, or reducing with, sodium sulfide, are as simple in application and have an excellent fastness to washing and light. The first of the modern vat dyes, apart from artificial indigo, was introduced in the year of the Perkin Jubilee. This thio-indigo red approaches in its composition indigo on the one hand, and the sulfur dyes on the other; and can be reduced in the vat after the manner of indigo dyeing, or like the sulfur colors with sodium sulfide. Primuline, the discovery of A. G. Green, was the first of a highly important group of dyestuffs which can be diazotized and developed upon the fibre. For instance, primuline, developed with b-naphthol, gives a red, with resorcinol an orange, and with phenol a yellow. Dyes used in a simple bath of acid were introduced for wool, and another class, giving a high resistance to milling are dyed on chrome-mordanted wool, or together with the chrome in a single bath, or are dyed and then after-chromed. Sodium di-chromate was not used in the dyeing trades before the advent of the coal-tar colors. It is now used in enormous quantities. The vat colors, used for both wool and cotton, are the most modern of dyes. On cotton they realize the ideal of fastness, resisting constant visits to the laundry, and outlasting the material itself. This is necessarily a mere glance at the types of dyestuffs which have been introduced for every special purpose.

If the textile colorist's work has been simplified in some directions, it has been rendered more difficult in others. He has the choice of a multiplicity of dyes, and the wisdom of his choice may determine the difference between profit and loss. Whereas his ante-coal-tar color brethren kept more or less to long-traveled paths, the modern dyer and printer is working under constantly changing conditions. Indigo, madder, and logwood were the coloring matters used on a wholesale scale before the days of Perkin, and each was in the hands of specialists of life-time experience. Now the color makers are not only in competition with each other, but with themselves, so to speak. No sooner do they put a color onto the market than they try to improve on it, and a much used dyestuff may be almost obsolete in a decade.

The introduction of the coal-tar colors has had important results on the natural dyes. Logwood was formerly sent to the dyer in logs and chips, and the "ageing" process, that is, the oxidation of the coloring principle, was a delicate operation which required experience. This, and other woods, are now sent out in powder and in liquid extracts, ready for the immediate use in the dye bath. Cutch, fustic, Persian berries, and other largely used natural colors are also prepared in the same way. The introduction of the synthetic dyes led gradually to a very extended use of machinery. As a rule, this is of a simple description; but it has, of course, almost revolutionized dye-house practice, and has led to a remarkable speeding up of the work.

The Physical Basis of Color Technology.

In the Journal of the Franklin Institute for July, 1917, M. Luckiesh, of the Nela Research Laboratory, contributes an exhaustive study on "The Physical Basis of Color Technology," which contains much of interest to those engaged in the analysis of coal-tar colors. The details of procedure for the use of spectro-photometric methods in the study of pigments and of soluble dyes are given in great fulness. These methods furnish data which promise to be of manifest utility in the selection of soluble coloring materials for a variety of purposes.

Government Control of the British Dyestuff Industry

The president of the British Board of Trade has established a special department of the Board for the temporary control of the dye industry, particularly in regard to expansion and the details of manufacture. The object of the department is the further development of the industry in Great Britain. The executive oversight is vested in Sir Evan Jones with the official title of Controller of Dyes.

The appointment of a controller, who is not a professional chemist, has excited much adverse criticism. One of the most forcible expressions in this connection comes from Prof. H. E. Armstrong, who did so much in 1915 to formulate the necessity of unity and government co-operation in building up the British dyestuff industry.

There is so much in common between the American and British efforts to create self-contained national dyestuff industries, that a portion of Prof. Armstrong's comments on the action of the Board of Trade may profitably be reproduced.

"A year ago I drew special attention to the critical condition of the dyestuff industry, owing to our failure to bring about a satisfactory and comprehensive organization of the very numerous interests which must be brought into effective co-operation if our needs are to be supplied and the industry is to be maintained in competition with other countries.

"To quote the opening paragraph of my article on the subject:—

"'It is beyond question that the situation in which this British dyestuff and allied industries are placed at the moment is extremely serious, and that the steps taken thus far have been such as to jeopardize the future rather than to establish conditions which would have promoted development. The failure of the Government to deal with the problem comprehensively, especially the action which they have taken in subsidizing only one of the firms in the country, more or less to the detriment of the others, is producing results which must militate against progress, and may even render the ultimate recovery of our position impossible.'

"It is well known that very little use has been made in the interval of the scientific talent of the country. There has been much boasting of what has been done by 'research'; but it amounts to very little in comparison with what has to be done. Individual firms may have made substantial progress as well as money, but this appears to have retarded rather than promoted collective development, as the terms on which these firms will now enter into association have been advanced. Organization, easy a year ago, is more difficult today.

"There has been an expectation of late that a comprehensive organization of the dyestuff industry was about to be effected, but apparently the negotiations have failed. Instead, we were told on June 19 that Sir Evan Jones, Bt., M.I.C.E., had been appointed Commissioner for Dyes and head of a special temporary department of the Board of Trade to promote the further development of the dye-making industry in the United Kingdom. The department has been formed to deal with matters relating to the encouragement, organization, and, so far as necessary, the regulation of the dye-making industry. In addition, we are now informed that Sir Evan Jones has also been appointed Controller of a Petrol Control Department—as if dyes were not sufficient for one man.

"Verily we are given stones where we ask for bread. What the country needs is a self-respecting, self-contained, self-governing industry—not a new bureaucratic Government Department to red-tape and delay progress. Sir Evan Jones is distinguished as an engineering contractor—no one will question his ability in his own sphere. But how can an engineer have the technical feeling required in an industry of so special and complex a character as that of dye-making? There are few professed chemists who have mastered it, who can deal with its problems intelligently. As well ask a chemist to superintend the manufacture of ordnance or the building of ironclads!

"It cannot be too clearly and forcibly stated that there can be no real progress in our country in matters in which special technical knowledge is of primary importance so long as control is placed in the hands of men without such knowledge. During the war various individuals and innumerable committees have been appointed to deal with scientific problems of which they have no real understanding, and vast sums have been squandered. The worst case of all, perhaps, is the appointment of purely literary men, without scientific training or experience, to superintend and organize the work of scientific and technical research. It is things such as these that make one despair of our future when once more competition rules the world."

A New Class of Yellow Azo Colors.

Meister Lucius and Brüning (Hoechst) obtain a new series of yellow, chromable azo colors (Ger. Pat. 295,051) from the action of 1-sulfo-aryl-pyrazolons, or their derivatives on diazo compounds of anthranilic acid and various substitution products of the same.

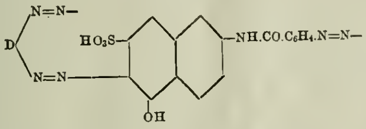
A New Series of Sulfur Yellows.

The Bayer Co. (Ger. Pat. 295,104) gives details regarding the production of very fast yellow sulfur dyes by the use of alkaline polysulfides on the carboxylic acids and the sulfonic acids of the ethylated amines of benzene, naphthalene and other aromatic hydrocarbons.

New Azo Colors for Use on Vegetable Fibers

Herbert Levinstein and James Baddiley, of Blackley, Manchester, England, assignors to Levinstein, Limited, of Manchester, have brought out (American patent 1,232,056, of July 3, 1917) a new series of substantive azo colors, intended for use chiefly on cottons and other vegetable fibers.

This new series is essentially an elaboration of a class of colors described by the inventors in 1912 (Br. Pat. No. 27,525 of 1912) and obtained by coupling two molecules of resorcin with a tetrazo body of the following general formula:—

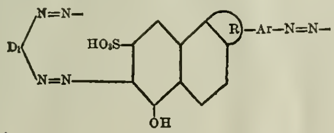


In the above formula D is a residue of the general constitution

Ar.CO.NH.Ar

Ar representing an aryl radical. Bright substantive orange, red, or brown dyestuffs are obtained by this reaction, which, after dyeing, are fixed with formaldehyde on vegetable fibers. Shades faster to boiling soap solutions than those produced by developed dyestuffs are thus secured far more conveniently than by methods involving the use of either developed or vat colors.

In their latest patent the inventors enlarge notably the range of shades by coupling two molecules of resorcin with tetrazo compounds of the formula:—



R indicates a ring formation containing nitrogen and includes 1.2-aminoaryl: triazol-, oxazol-, thiazol-, imidazol-, azimido-, residues of the compounds indicated in the formula.

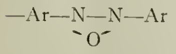
D_1 may be a residue of the following constitution

—Ar. CO.NH.Ar—

—Ar—Ar—

—Ar—CH=CH—AR—

—Ar—N=N—Ar.



$-Ar-\underset{\diagdown O \diagup}{N-N}-Ar$

—Ar—S—Ar—

—Ar—O—Ar—

—Ar—CS—Ar

—Ar—O—CH_2—CH_2—O—Ar

—Ar—O—C_6H_4—O—Ar—

Ar indicates an aromatic radical.

The general method is illustrated by the following example:

256 parts of m-m-diamino-azoxy-toluene are converted into the tetrazo compound by means of 138 parts of sodium nitrite, and the necessary amount of hydrochloric acid. The tetrazo compound is combined in soda-alkaline solution with 356 parts of m-amino-phenyl-1 : 2-naphthimidazol-, 5 oxy-, 7-sulfonic acid. The intermediate compound thus obtained is rediazotized by means of 68 parts of sodium nitrite and the necessary quantity of hydrochloric acid. The resulting tetrazo compound is combined with 220 parts of resorcin in the presence of an excess of sodium carbonate. When the combination is completed the dyestuff is isolated in the usual manner. It dyes cotton directly. When the dyeings are aftertreated with 3% formaldehyde (40%), at a temperature of 70°—80° C., for 20—30 minutes, yellowish-red shades, extremely fast to boiling soap solution are obtained.

If instead of diamino-azoxy-toluene in the above example, m-amino-benzoyl-m-phenylene-diamine is used, similarly fast shades are obtained, but of a yellowish tone.

Color Lakes Derived from Complex Tungstic Acids

Carl Immerheiser, of Ludwigshafen-on-the-Rhine, and Anton Beyer of Mannheim, Germany, assignors to the Badische Anilin & Soda-Fabrik, of Ludwigshafen, describe (Amer. Pat. 1,232,552, of July 10, 1917) the preparation of a class of color lakes possessing great brilliancy, and extremely fast to water and light, obtained by precipitating basic coal-tar coloring matters by means of a complex acid containing tungsten, for instance, phosphotungstic acid and silcotungstic acid. Especially satisfactory results are secured by using the phospho-duodeci-tungstic acid and the phospho-luteo-tungstic acid described in the Zeitschrift für Anorganische Chemie, vol. 1, page 431.

The following example serves to illustrate the process employed in making the different lakes: Mix one hundred parts of a ten per cent. paste containing aluminum hydrate and barium sulfate (obtainable by mixing together aqueous solutions of ten parts of aluminum sulfate containing 18% Al_2O_3, five parts of calcined sodium carbonate and twelve parts of barium chloride) with a solution of one part of Crystal Violet (a salt of hexa-methyl-triamino-tripheny-carbinol) in one hundred parts of water. Then add an aqueous solution of from two to three parts of acid sodium phospho-duodeci-tungstate until the coloring matter is completely precipitated. The pure violet lake is filtered off and can be worked up in the usual manner.

The precipitation can take place at ordinary or elevated temperatures, and with or without the addition of Turkey red oil, sodium acetate, or other similar substances. The precipitation can, for instance, be carried out in the presence of any suitable substratum, and the concentration of the various ingredients can be varied within wide limits.

Instead of Crystal Violet other basic coal-tar coloring matters can be used, such as other violets of cognate nature, the dyestuffs of the Rhodamine, Auramine, and Malachite Green series, or the dyestuff which can be obtained by condensing benzaldehyde-o-sulfonic acid with diethyl-aniline and sulfonating the condensation product and dyestuffs of a similar nature. In lieu of the sodium phosphoduodeci-tungstate other complex acids of tungsten, or salts thereof, are equally suitable for the purpose in view.

New Wool Disazo Dyestuffs

Eugen Anderwert and Heinrich Schobel, of Basel, Switzerland, assignors to the Society of Chemical Industry, of Basel, announce (Amer. Pat. 1,233,742, of July 17, 1917) the discovery of a new series of disazo colors, applicable to wool and other animal fibers, giving very pure tints of marked fastness to both light and washing.

The members of the new series are obtained by combining the tetrazo derivative of a 3-3′-diamino-diaryl-methane compound with two molecules of azo dyestuff components, whereof at least one is a molecule of a naphthol-sulfonic acid. As 3-3′-diamino-diaryl-methane compound may be employed advantageously the 3-3′-diamino-4-4′-dimethyl-diphenylmethane, the 3-3′-diamino-diphenylmethane and their derivatives.

The resultant dyestuffs yield a variety of tints ranging from scarlet to orange and yellow.

The reaction may be varied in numberless ways. The following examples illustrate some of the more important products and the methods of their preparation:—

Example 1: 22.6 kg. of 3-3′-diamino-4-4′-dimethyl-diphenyl-methane are dissolved in 60 kg. hydrochloric acid and tetrazotized at about 0° C. with a solution of 14.2 kg. sodium nitrite. The resulting solution of tetrazo compound is poured, under constant stirring, into a solution of 52 kg. 1-4 naphthol-sulfonic acid and of 50 kg. sodium carbonate. After standing for a long time, the mass is heated at 60° C., and the dyestuffs is salted out, filtered off, pressed and dried. It constitutes a red powder, which dissolves in water and in concentrated sulfuric acid with a red coloration. It dyes wool in an acid bath very pure red tints possessing a very good fastness to washing and to light.

Example 2: By substituting in Example 1 for 1-4-naphthol-sulfonic acid the same quantity of 2 6-naphthol-sulfonic acid, the resulting dyestuff dissolves in water and concentrated sulfuric acid to a yellow-red solution. It dyes wool in an acid bath very pure yellow-red tints of a good fastness to washing and to light.

Example 3: The tetrazo compound, prepared according to Example 1, is poured, while stirring, into a solution of 34.8 kg. 2-naphthol-3-6-disulfonic acid and of 50 kg. of sodium acetate, at about 0° C. After stirring for about 2 hours the intermediate product is obtained. It is poured into a solution of 15 kg. of b-naphthol, 13 kg. of soda lye of 30 per cent. and 50 kg. of sodium carbonate. After stirring for a long time, combination is completed and the dyestuff is isolated in the usual manner. It dissolves in water and concentrated sulfuric acid to red solutions and dyes wool, in an acid bath, pure scarlet-red tints, of a good fastness to fulling and to light.

Example 4: The solution of tetrazo compound derived from 22.6 kg. of 3-3′-diamino-4-4′-dimethyl-diphenyl-methane, according to Example 1, is mixed with the solution of 27.6 kg. of 1 (4′-sulfo-)-phenyl-3-methyl-5-pyrazolone and of 50 kg. of crystallized sodium acetate. After formation of the intermediate product, requiring about 2 hours, the mass is poured into a solution of 26 kg. of 1-4-naphthol-sulfonic acid and 50 kg. of sodium carbonate. The combination being effected, the dyestuff is isolated in the usual manner. It dissolves in water and concentrated sulfuric acid to orange solutions and dyes wool, in an acid bath, red-orange tints fast to washing and to light.

Instead of the 1-(4′-sulfo-)phenyl-3-methyl-5-pyrazolone can be employed with similar success the 1-phenyl-3-methyl-5-pyrazolone itself, or its nitro- or carboxyl derivatives, the acetoacetanilide, the methyl-ketol, etc.

Example 5: 19.8 kg. of 3-3′-diamino-diphenyl-methane are tetrazotized with 60 kg. of concentrated hydrochloric acid and 14.2 kg. of sodium nitrite. The resulting tetrazo compound is poured while stirring into a solution of 52 kg. of 1-4-naphthol-sulfonic acid and of 50 kg. of sodium carbonate. After some hours, the dyestuff is separated by heating to 30° C. It is salted out, filtered off, pressed and dried. It constitutes a red powder dissolving in water and concentrated sulfuric acid to red solutions. It dyes wool, in an acid bath, pure scarlet-red tints of a good fastness to fulling and to light.

Example 6: By substituting for the 1-4-naphthol-sulfonic acid employed in Example 5 the same quantity of 2-6-naphthol-sulfonic acid, the resulting dyestuff dyes wool in an acid bath pure yellow-red tints of good fastness.

The inventors attach the most importance to the bright red dye obtained in the first example. The general reaction is, however, one of distinct promise.

The Use of Phosphomolybdic Acid in Producing Color Lakes.

Carl Immerheiser, of Ludwigshafen-on-the-Rhine, Germany, assignor to the Badische Anilin & Soda-Fabrik, of Ludwigshafen, has recently devised

(Amer. Pat. 1,232,551, of July 10, 1917) a method for preparing an extensive series of color lakes which consist of insoluble combinations of various basic coal-tar dyes with phosphomolybdic acid. These lakes possess great brilliancy, are extremely fast to water and very fast against the action of light.

The following example serves to illustrate the general method of preparing such a lake: Mix together 10 parts of heavy spar, a solution of 5 parts of aluminum sulfate (containing 18% Al_2O_3) in 50 parts of water, a solution of 2½ parts of calcined soda in 25 parts of water and a solution of 6 parts of barium chloride in 60 parts of water. Then add a solution of one part of Diamond Green G (a salt of tetra-methyl-diamino-triphenyl-carbinol) in 200 parts of water, and a solution of from 2 to 3 parts of sodium phosphomolybdate in from 20 to 30 parts of water. Filter off the color lake and prepare it in the usual manner.

Use of Methyl Red as an Indicator in the Determination of the Hardness of Natural Waters, S. A. Kay and Susan H. Newlands (J. S. C. I., 1916, *35*, 445), describe modified procedures for the determination of temporary and permanent hardness by the use of Methyl Red. It is claimed that the proposed methods are more accurate than those now in common use.

NATURAL DYES

The Art of Dyeing

A Survey of Processes and Methods

By Clement Bolton

[The following clear and compact portrayal of the current methods employed in the use of coloring materials is from the pen of a leading British authority, and will be welcomed by those conversant rather with the manufacture and sale of dyestuffs.—Ed.]

The affairs of the dyeing trade have had much publicity given to them during the past two and a half years. It is possible, however, that the somewhat sensational treatment devoted to the subject has left but a hazy idea of the trade as a whole. A general survey may therefore be useful in helping to put matters into better proportion.

Dyeing processes are applied to many materials. The most important are the textiles. It is difficult to supply a short definition of all that is implied in the word dyeing, but in general it means the giving to some material a color that is more or less uniform, thorough, and permanent. This differentiates it from painting and printing.

In "painting" the pigment or coloring matter is superficial and obvious. The object painted is covered and hidden by the paint. "Printing" connotes some idea of pattern, and is usually, but not always, superficial. "Dyeing" suggests dipping, or at any rate a very thorough impregnation. Color is not tangible matter, but only an attribute. Dyed material must not give tangible evidence of the coloring matter, but only of the attribute. The dyer takes, say, some wool and some substance with the attribute of redness. At the finish of his operations the wool has the redness, but what of the colored substance from which the redness came? It has gone to practically oblivion—that is, if the wool has been properly dyed. If that colored substance is actually visible on the surface of the wool then it is not dyed, but only daubed on. If the wool satisfies the eye, yet if mere rubbing on white paper or a white handkerchief causes a stain, then the advance from daubing to proper dyeing has not been completely achieved.

The Question of Fastness.

There are many agencies which tend either to destroy the color of a dyed fabric or to dissociate the union of dye and fibre: for example, washing, rubbing, and light. No dyeing attains absolute permanence against every adverse agency. Still some colors are as permanent as the material on which they are dyed. This is surely as much as is necessary to expect. All-round fastness is really more than is necessary in many cases. For instance, if upholstering or carpets, or bookbinder's cloth are fast to light and rubbing, what does it matter if they are not fast to washing—they are never washed? Underclothing should be fast to washing and rubbing and perspiration, but need not be particularly fast to light. Thus, if the dyer meets the reasonable requirements of the material he has attained to a reasonable degree of perfection.

We said that dyeing connotes the idea of dipping, but this must not be taken to mean that it is sufficient to immerse in any colored solution to get a corresponding color on the article dipped. The dyer's lot is not so easy. For instance, copper sulphate is known as blue stone because of its color, but it gives to wool a light greenish drab tint, and affects cotton not at all. A solution made from ammonia and copper oxide has a still more intense blue, but boil any textile material in it and the puzzle will be to recover it, for instead of being dyed it will be dissolved. In fact a cuprammonium solution of cotton is one source of artificial silk. The very concentrated solution is squeezed through capillary tubes into a precipitating reagent, and the cotton materializes again as rod-like, lustrous threads.

There are, of course, some coloring matters that will dye from simple solutions. One series of coal-tar colors is called the basic series. The well-known bright red, magenta is one of them. Most of the series will dye wool or silk direct from a hot solution. There is another series called the acid dyes. From simple solution they give wool or cotton only thin, washy shades. But let about as much sulfuric acid as dye be present, and the wool will be well dyed. The cotton will be left white.

Direct Cotton Dyes.

Another series is that of the direct cotton colors. These will dye both cotton and wool to some extent from simple solution, but much better if the specific gravity of the bath is raised by the addition of salt. Still further improvement is obtained if, in the case of cotton, some alkali is added to the bath, or, for wool, some weak organic acid, for instance, acetic acid. It is obvious from this statement that these dyes are soluble in either weak acid or weak alkali. But the sulfur colors, another very important series produced by the reaction of sulfur or sodium sulfate on various coal-tar intermediates, require a rather caustic alkali for their solution. Cotton and linen can stand this alkali, and as the colors have excellent fastness, and are very cheap, they are used to an enormous extent on the vegetable fibres. But wool and silk are dissolved by quite weak caustic alkali, and the series is therefore practically useless for these fibres.

Dyeing is not always a matter of one dip. Until the advent of the coal-tar dyes it was the exception. It was one of the advantages of these dyes that they gave to many branches of the trade the possibility of managing with one bath. The average fastness of the one-dippers, however, is poor. Dyes that are put on most easily come off most easily as a rule.

As to the theory of dyeing there is great controversy. The one-dip processes we have mentioned lend support to the solution theory. The material to be dyed, though a solid, is considered to be a solvent. The water of the dye-bath is, of course, also a solvent and has the dye held in solution. The solution has mobility and distributes itself between the two solvents, the water and the fibre, until equilibrium is established. If the water is the more powerful solvent a good deal of dye will be left in it, but if the fibre has the greater power, then the liquor becomes exhausted of dye. The dyer adds assistants to his dye-bathes—sometimes they are meant to help exhaustion and sometimes to retard it. In the former case the idea is to get all the value possible out of the bath. In the latter case it is to prevent the color from rushing on and so producing uneven results.

Dyeing processes which require two or more stages seem to the present writer to require some chemical explanation. Instead of conveying colored substances into the pores of the fibres, the dyer actually produces the substance in situ. This is what happens with "mordant" dyestuffs. The characteristic of these is that they give colored precipitates when boiled with metallic salts known as mordants. These precipitates are called "lakes," and can be used by painters as pigments. The dyer, however, does not usually prepare the lake away from the fibre. He gets one constituent into the pores and then brings the other to it, and the lake is formed in the very substance of the material. It is easier to do this on wool than on cotton. Wool is more active, chemically speaking, than cotton. If it is boiled in solutions of salts of iron, copper, tin, alum, or bichromates, the salts are dissociated, the metal part being absorbed by the wool. A second treatment in boiling solution of dye results in lake formation and a fast dyeing. From the same dyestuff various colors can be obtained by using various "mordants," as the metallic salts are called. Thus alizarin with iron gives a violet, with chrome a maroon, with alum a scarlet, and with tin an orange. Such a dyestuff is called polygenetic.

Complicated Processes.

The cotton dyer has to go beyond two stages when fixing many mordant dyes. Cotton has no great affinity for either the mordant or the dye. He therefore requires some chemical which has a double affinity—on the one hand for the cotton, and on the other hand for the mordant. Tannic acid and its near relations provide this. The cotton is steeped either in tannic acid or some tannin material, such as extract of sumach, chestnut bark, or myrabolans. The tannic acid and its relatives are absorbed, though not very strongly. The next treatment, with some metallic salt—say, acetate of iron—has the twofold benefit of fixing both the tannic acid and the metal. Then the dyestuff can be put on top, and a color lake is fixed in the fibre. The chief mordant dyestuffs are logwood, for blacks on all fibres, and alizarin, for Turkey red on cotton. The latter furnishes, perhaps, the most elaborate of dyeing processes. The cotton is first treated with oil, then with tannin, then with mordant, in this case alum, and then with dye. Some of the treatments have to be repeated. The total number of operations is 14, and the time occupied may be several days. Even this is an improvement on the original Eastern procedure, which, it is said, lasted three months. The alum-alizarin lake on wool may be fixed in two hours.

The older mordant dyes had not much affinity for the textile fibres, hence the usual practice of mordanting first. But the gap between them and the acid colors is now filled in by others whose properties partake of both groups. They have proved particularly useful in wool dyeing. They are applied, first, from an acid bath, and then fastened with a mordant. Usually the mordant causes a considerable change of shade. A black dye, for instance, shows red at the first stage, and turns to black by treatment with a bichromate. The acid mordant blacks are superior to the old-fashioned logwood black in most respects. They were used in enormous quantities before the war, and will be used again as soon as they can be made.

The acid and direct cotton colors are mostly the product of certain coal-tar intermediates called amines, aniline itself being a typical example, combined with others called phenols and naphthols by means of what is known as a diazotizing process. It is only the soluble products that are dyes, but there are others, which, being insoluble, can be used as pigments. The dyers of vegetable fibres can effect the manufacture of these pigments in the pores of cotton, linen, etc.

Many Branches of Trade.

From the brief description it will be readily understood that the dyeing trade is not one, but many. The chief divisions are, according to the material—wool dyeing, cotton dyeing, etc. Each of these further subdivides according to the stage of manufacture. The material may be raw, spun into thread, or woven in the piece. The thread or yarn may be in several forms—hanks, warps (sometimes miles long), cops, or cheeses.

The tendencies in the dyeing trade are similar to those in other trades that cater for the public. Some people require the best, no matter at what cost. Others seek cheapness, with its necessary concomitants. With others, again, novelty, nice or otherwise, is the requirement. The dyeing trade caters for them all.

Better results, new effects, less costs, simpler processes—the dyer aims at all these. A recent writer has expressed it rather differently. He says that the perfect dyestuff, to which we are evolving, must dye level, cost nothing, and smell like violets. But the youngest of dyers will have matched off his last batch, and still the perfect dyestuff will be in the future.

Fire in the Works of the American Synthetic Color Co.

The American Synthetic Color Co., at Stamford, Conn., lost by fire on July 21 one of the buildings of its extensive plant, and a small annex. The mechanical equipment of the building was destroyed, and there was a serious loss of material in course of manufacture. This plant has been an active factor during the past two years in the production of coal-tar intermediates, and the company has formulated plans for taking up the manufacture of dyestuffs.

Lullaby.

Atomize antiseptics as baby girl sleeps,
While the infra-red ray through the nursery room sweeps.
Let powdered iodoform fall in soft flakes,
And kill all bacilli ere baby awakes. —*Life.*

Color Trade Journal, Vol. 1, No. 1, August, 1917

Published by the "Color Trade Journal, Inc.," 200 Fifth Avenue, New York, J. Merritt Matthews, Pres.; C. Cyril Bennett, Sec.-Treas. $5 Per Annum.

It is a pleasure to welcome to the group of periodicals devoted to the furtherance of American chemical industry this latest addition, the *Color Trade Journal*. The initial number gives every promise that it will do stalwart work in furthering, stimulating and protecting the many diversified interests in this land which are engaged in the production of coloring matters and in their application.

Dr. J. Merritt Matthews, the editor, has been closely identified for many years with the struggle to build up an American dyestuff industry and with every phase of the utilization of colors in the textile and allied branches. No one is more familiar with the difficulties to be overcome in making our American color industry self-contained and independent; no one is better fitted to impart helpful counsels and indicate the most needed and the most favorable lines of progress. As the author of a standard manual for laboratory instruction in dyeing, he has earned the grateful regard of all the younger school of tinctorial chemists in this country.

Associated with Dr. Matthews is Mr. Cyril Bennett, well known, especially in Washington, as a journalist of forceful style, closely familiar with economic problems, and personally identified with the movement to ensure by suitable legislation the permanence of our young dyestuff industry.

The first number contains a variety of articles contributed by men of prominence in color chemistry and closely related fields. There is an abundance of illustrations, including tasteful vignettes of most of the contributors. Paper and typography are excellent. The handsomely executed cover design in colors is most happily in harmony with the character and purpose of of the journal.

All in all, the *Color Trade Journal* is a credit to American trade journalism, and our color chemists have every reason to appreciate Dr. Matthews' admirable work on their behalf. Its appearance is an added proof of the conviction by all connected with the dyestuff industry in our country, that it is founded upon a sure and permanent basis, ready to face the struggles for supremacy on the part of foreign rivals, which may follow the end of the great war.

New Quarters for National Aniline & Chemical Co.

The National Aniline & Chemical Co. will shortly occupy three floors of the new Heckscher Building, at 244 Madison Avenue, New York City. For over twenty years the company has been located at 100 William Street.

Disastrous Conflagration in the Factory of the Seydel Manufacturing Co.

On July 9 there was a serious fire in the dyestuff works of the Seydel Manufacturing Co., Jersey City, which caused a loss of about $150,000. The disaster resulted from the boiling over of a large tank containing benzoic acid. The contents took fire and the flames spread rapidly throughout the large building. A huge pall of dense, black smoke hung over the entire neighborhood, extending for half a mile in every direction. The evolution of noxious fumes was such that firemen were seriously hindered in their efforts to check the flames. Nine firemen were rendered unconscious for varying periods. There were, fortunately, no fatalities. Railroad traffic on the adjacent railway lines was interrupted for over two hours.

Explosion in the Beckers Works.

An explosion occurred on July 1 in one of the buildings of the W. Beckers Aniline and Chemical Works, in Brooklyn. Four operatives were seriously burned, one of whom is not expected to recover. The explosion was regarded as due to the presence of a large amount of easily combustible dust in the air, and there was no indication that it was brought about intentionally by outside parties.

Explosion in the Works of the Midvale Co.

There was a bad explosion of aniline oil and benzene in the plant of the Midvale Chemical Co. at Elizabeth, N. J., on July 7, causing damages to the extent of $50,000. The explosion was caused by a leak in an aniline still.

CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS

CRUDES.

Anthracene, 80 p.c.	lb.	.50	—
Benzol, pure, water white	gal.	.55	.60
Benzol, 90 p.c.	gal.	.53	.55
Cresol, U. S. P.	lb.	.18	.20
o-Cresol	lb.	.30	.35
Cresylic acid, 95-97 p.c.	gal.	1.05	1.10
Cumene (pseudo)	lb.	..	..
Dip oil, 20 p.c.	gal.	.28	.30
Naphthalene	lb.	.09¼	.10
Flake	lb.	.09	.09½
Balls	lb.	.10	.10¼
Phenol (carbolic acid), U. S. P., cryst., drs.	lb.	.40	.42
Bottles	lb.	.50	—
Pitch, various grades	ton	8.00	20.00
Pyridine	oz.	—	.25
Solvent naphtha, water white	gal.	.19	.23
Solvent naphtha, crude, heavy	gal.	.13	.16
Toluol, pure, water white	gal.	1.80	1.90
Toluol, commercial 90 p.c.	gal.	1.75	2.00
Xylene, pure	gal.	.50	.65
Xylene, commercial	gal.	.35	.40

INTERMEDIATES AND EXPLOSIVES.

Amido-naphthol-disulfonic acid (H-acid: 1.8.3.6)	lb.	2.80	3.50
Amido-naphthol-sulfonic acid	lb.	—	1.75
p-Amido-phenol	lb.	5.00	5.50
p-Amido-phenol hydrochloride	lb.	5.75	6.00
Amino-azo-benzene	lb.	1.75	1.85
Aniline oil	lb.	.28	.30
Aniline salts	lb.	.33	.35
Aniline for red	lb.	1.10	1.15
Anthraquinone	lb.	—	—
Benzaldehyde	lb.	4.00	4.50
Oil of bitter almonds	lb.	12.50	13.50
Without acid		17.00	18.00
Benzidine	lb.	1.80	1.90
Benzidine sulfate	lb.	1.60	1.70
Benzoic acid	lb.	3.50	3.75
Crude	lb.	3.00	3.50
From gum	lb.	7.25	7.50
Benzychloride	lb.	1.75	2.00
Chloro-benzene	lb.	.28	.30
Cumidine	lb.	—	—
Diamido-phenol	lb.	—	—
o-Dianisidine	lb.	—	—
Dichloro-benzene	lb.	.15	.20
o-Dichloro-benzene	lb.	—	—
p-Dichloro-benzene	lb.	.21	.24
Diethyl-aniline	lb.	3.00	3.20
Dimethyl-aniline	lb.	.60	.65
Dinitro-benzene	lb.	.33	.35
m-Dinitro-benzene	lb.	.45	.50
Dinitrochloro-benzene	lb.	.46	.48
Dinitro-naphthalene	lb.	.60	.70
Dinitro-phenol	lb.	.62	.66
Dinitro-toluene	lb.	.57	.62
Diphenylamine	lb.	.90	1.10
Dioxy naphthalene	lb.	—	—
Ethyl-aniline	lb.	1.25	1.40
Hydrazine sulfate	oz.	—	.80
Hydroquinone	lb.	2.00	2.10
Hydrazobenzene	lb.	1.50	2.00
Methylanthraquinone	lb.	—	—
Metanilic acid		—	—
Naphthalene-diamine	lb.	—	—
Naphthionic acid, white	lb.	1.80	1.90
a-Naphthol	lb.	2.30	2.90
b-Naphthol	lb.	.70	.75
Sublimed	lb.	.85	.90
Naphthosulfonic acid		—	—
a-Naphthylamine	lb.	.80	1.00
b-Naphthylamine	lb.	1.75	2.00
Sublimed	lb.	2.75	3.00
p-Nitraniline	lb.	1.10	1.20
Nitrobenzene	lb.	.21	.22
Oil of Mirbane, ref.	lb.	.19	.20
o-Nitrochloro-benzene	lb.	.50	.56
Nitro-naphthalene	lb.	.60	.65
Nitro-naphthol	lb.	—	—
Nitrotoluene	lb.	.55	.60
o-Nitrotoluene	lb.	1.00	1.25
p-Nitrotoluene	lb.	1.40	1.50
m-Phenylene-diamine	lb.	1.90	2.00
p-Phenylene-diamine	lb.	3.50	4.00
Phthalic acid	oz.	—	.60
Phthalic anhydride	lb.	6.40	6.50
Picric acid, kegs	lb.	.75	.80
Pyrocatechin resublimed	oz.	—	.80
Resorcinol, cryst., U. S. P.	lb.	12.50	13.00
Technical	lb.	8.50	9.00
Salicylic acid, U. S. P.	lb.	1.45	1.50
Sulfanilic acid	lb.	.32	.34
Tetra-nitro-methyl-aniline	lb.	—	2.50
Tolidine	lb.	3.00	—
Toluidine	lb.	.80	.85
o-Toluidine	lb.	.90	1.00
p-Toluidine	lb.	2.00	2.25
m-Toluylene-diamine	lb.	1.70	1.75
Xylidine	lb.	.80	.90

SYNTHETIC MEDICINALS, FLAVORS AND PERFUMES.

Acetanilide C. P., bbls.	lb.	.50	.54
Acetphenetidine	lb.	18.00	20.00
Acetyl-salicylic acid, bulk	lb.	—	3.50
Ammonium benzoate	lb.	11.00	—
Ammonium salicylate	lb.	1.60	1.63
Antipyrene, bulk	lb.	22.00	23.00
Benzanilide	oz.	—	2.50
Benzonaphthol	oz.	—	.85
Bismuth phenolsulfonate	lb.	—	9.30
Bismuth salicylate	lb.	—	3.20
Bismuth salicylate, 40 p.c.	lb.	—	4.75
Bismuth sub-benzoate	lb.	8.50	9.50
Bismuth subsalicylate, basic, U. S. P.	lb.	—	5.20
Caffeine benzoate	oz.	1.25	1.55
Caffeine salicylate	oz.	.90	1.00
Calcium benzoate	oz.	—	.40
Calcium salicylate	lb.	—	—
Calcium sulfocarbolate	lb.	1.42	1.45
Ethyl benzoate	lb.	—	8.00
Guaiacol salicylate	oz.	1.60	—
Lithium benzoate	lb.	8.00	8.25
Lithium salicylate	lb.	4.00	4.40
b-Naphthol benzoate	oz.	—	1.10
Phenacetin (Bayer)	oz.	—	2.40
Phenacetin (L. & F.)	oz.	—	2.40
Phenolphthalein	lb.	15.00	16.00
Potassium salicylate	lb.	3.00	3.25
Pyoktanin Blue	oz.	2.50	3.00
Pyramidone	oz.	—	2.50
Saccharin	lb.	42.00	45.00
Salipyrine	oz.	—	.80
Salol, U. S. P.	lb.	1.50	1.75
Salol	lb.	1.95	2.05
Salophen	tube	1.50	1.80
Sodium benzoate, granulated, U. S. P.	lb.	3.50	3.75
Sodium salicylate, U. S. P.	lb.	.85	.95
Strontium salicylate, U. S. P.	lb.	1.15	1.25
Sulfocarbolic acid (30 p.c.)	oz.	—	.25
Sulfosalicylic acid	oz.	.65	.75
Tolypyrine	oz.	—	1.25
Triphenine	oz.	—	.50
Wintergreen oil synthetic, U. S. P.	lb.	.75	.80
Zinc salicylate	lb.	—	3.25

PHOTOGRAPHIC DEVELOPERS.

Adurol, 16 oz. bottles	ea	—	10.00
Agfa (intensifier) 2-oz. bottle		—	.40
Amidol 1-oz. bottle	oz.	.65	.75
Dianol 1-oz. bottle	oz.	—	.80
Edinol		—	—
Eikonogen	oz.	—	.45
Glycin, 1 oz. bottle	oz.	—	.80
Hydroquinone	lb.	2.00	2.10
Metacarbol		—	—
Metol	oz.	—	—
Monomethyl-p-amido-phenol (identical with metol)	oz.	—	3.50
Nerol (identical with amidol), 1 oz.	oz.	—	.30
Ortol, 1-oz. bottle	oz.	—	.80
Pyrogallic acid, crystals	lb.	2.95	3.15
Rhodol	lb.	—	—
Rodinal, 3-oz. bottle	ea.	—	.75

ARTIFICIAL COLORS.

Acid Black	lb.	1.75	1.80
Acid Blue	lb.	2.60	4.00
Acid Brown	lb.	1.50	2.00
Acid Fuchsine	lb.	8.00	10.00
Acid Green	lb.	3.50	4.00
Acid Orange	lb.	1.00	1.50
Acid Orange II	lb.	1.00	1.25
Acid Orange III	lb.	1.25	2.00
Acid Red	lb.	2.50	3.00
Acid Scarlet	lb.	4.00	5.00
Acid Yellow	lb.	2.50	3.00
Alizarin Blue	lb.	8.50	9.00
Alizarin Blue, bright	lb.	6.50	7.00
Alizarin Blue, medium	lb.	6.00	6.50
Alizarin Brown, conc.	lb.	8.50	10.00
Alizarin Orange	lb.	8.25	9.50
Alpine Red	lb.	6.00	7.00
Alpine Yellow	lb.	6.80	8.00
Auramine	lb.	4.00	5.00
Azo Carmine	lb.	5.50	6.00
Azo Yellow	lb.	2.00	2.50
Azo Yellow, red shade	lb.	3.50	4.00
Aurine	lb.	2.60	3.00
Bismarck Brown Y	lb.	1.60	2.00
Bismarck Brown FF conc.	lb.	2.00	3.00
Bismarck Brown 3 R	lb.	2.00	2.25
Bismarck Brown R	lb.	1.30	2.00
Bright Red	lb.	3.00	3.75
Chrysamine Yellow	lb.	1.60	2.60
Chrysoidine	lb.	1.75	2.10
Chrysoidine R.	lb.	2.00	2.25
Chrysoidine Y	lb.	1.75	2.00
Congo	lb.	4.50	5.00
Crystal Violet	lb.	7.50	8.00
Direct Acid Orange	lb.	1.10	1.25
Direct Black	lb.	1.00	2.00
Direct Blue	lb.	2.60	3.00
Direct Sky Blue	lb.	6.50	8.00
Direct Brown	lb.	2.00	2.80
Direct Bordeaux	lb.	2.50	3.50
Direct Fast Red	lb.	2.55	3.00
Direct Red	lb.	2.75	3.50
Direct Yellow	lb.	3.00	4.50
Direct Fast Yellow	lb.	2.40	3.00

Direct Violet	lb.	3.50	4.50
Eosine	lb.	10.00	15.00
Fast Red, 6B extra	lb.	3.50	4.00
T extra	lb.	—	2.00
Fast Scarlet	lb.	1.75	2.35
Fuchsine	lb.	7.50	12.00
Fur Black, extra	lb.	2.50	3.00
Fur Brown B	lb.	3.75	4.50
Fur Brown GG	lb.	6.25	8.00
Green Crystals	lb.	6.00	8.00
Indigo 20 p.c. paste	lb.	1.50	1.70
Indigotin	lb.	2.50	4.00
Induline	lb.	1.90	2.50
Magenta	lb.	10.00	12.00
Malachite Green	lb.	11.00	12.00
Metanil Yellow	lb.	2.50	3.00
Medium Green	lb.	2.50	4.00
Methylene Blue, tech	lb.	5.00	6.00
Methyl Violet	lb.	4.00	4.75
Naphthol Green	lb.	4.35	5.00
Nigrosine, oil sol	lb.	.80	1.00
Nigrosine, sp. sol	lb.	.90	1.00
Nigrosine water sol., blue	lb.	1.60	2.00
Jet	lb.	1.35	1.50
Naphthylamine Red	lb.	6.50	7.00
Oil Black	lb.	1.90	2.10
Oil Green	lb.	1.90	3.00
Oil Orange	lb.	1.90	2.10
Oil Scarlet	lb.	2.50	3.00
Oil Yellow	lb.	1.80	2.50
Orange, RG	lb.	1.50	2.00
Orange Y, conc	lb.	1.10	1.50
Ponceau	lb.	2.50	3.00
Quinoline Yellow	lb.	5.00	6.00
Rhodamine	lb.	3.25	6.50
Saffranine	lb.	15.00	20.00
Scarlet 2 R	lb.	3.00	3.25
Soluble Blue	lb.	17.00	20.00
Sulfur Black	lb.	.50	1.10
Sulfur Black 150 p.c	lb.	—	.85
Sulfur Blue	lb.	2.60	3.25
Sulfur Blue-Black	lb.	4.00	4.20
Sulfur Brown	lb.	.50	.60
Sulfur Green	lb.	2.00	3.00
Sulfur Yellow	lb.	1.60	2.00
Tartrazine	lb.	1.90	2.00
Wool Orange	lb.	2.25	3.25
Victoria Blue	lb.	17.00	20.00
Victoria Blue, base	lb.	18.00	21.00
Victoria Green	lb.	11.50	14.00
Victoria Red	lb.	7.50	8.00
Victoria Yellow	lb.	7.00	8.00
Yellow for wool	lb.	2.75	3.00

NATURAL DYESTUFFS.

Annatto, fine	lb.	.45	.60
Seed	lb.	.16	.17
Carmine No. 40	lb.	4.25	4.75
Cochineal, Teneriffe, Silver	lb.	.95	.98
Gray	lb.	.75	.80
Indigo, Bengal	lb.	3.75	4.00
Oudes	lb.	3.00	3.25
Guatemala	lb.	3.00	3.25
Kurpahs	lb.	3.15	3.60
Madras	lb.	1.40	1.45
Madder, Dutch	lb.	.25	.30
Nutgalls, blue Aleppo	lb.	—	—
Chinese	lb.	.30	.33
Persian Berries	lb.	—	—
Turmeric, Madras	lb.	.08¾	.09
Aleppey	lb.	.10	.10½
Pubna	lb.	—	—
China	lb.	.08	.08¼

DYEWOODS AND RAW MATERIALS.

Algarobilla	ton	140.00	150.00
Barwood	lb.	.06	.08
Camwood, chips	lb.	.18	.20
Divi-Divi	ton	62.00	—
Fustic, sticks	ton	30.00	35.00
Chips	lb.	.06	.07
Hypernic chips	lb.	.07	.08
Logwood, sticks	ton	30.00	35.00
Chips	lb.	.03	.05
Myrobolans	ton	64.00	65.00
Quercitron Bark No. 1	ton	28.00	31.00
No. 2	ton	20.00	25.00
Red Saunders, chips	lb.	.12	.14
Sumac, Sicily, 27 p.c. tannin	ton	86.00	88.00
Virginia, 20 p.c. tannin	ton	50.00	59.00

EXTRACTS.

Archil, double	lb.	.15	.17
Triple	lb.	.20	.23
Concentrated	lb.	.25	.30
Chestnut, 25 p.c. tannin	lb.	.02¼	.02¾
Clarified, 25 p.c. tannin	lb.	.02½	.03
Cutch, Rangoon, boxes	lb.	.12	.13½
Liquid	lb.	.08¾	.09
Tablet	lb.	.10	.12
Cubear, French	lb.	—	—
English	lb.	.18	.24
Concentrated	lb.	—	.38
Flavine	lb.	1.00	1.50
Fustic	lb.	.11	.12
Gall	lb.	—	.18
Gambier, 25 p.c. tannin	lb.	.10	.10½
Common	lb.	.16½	.17
Cubes No. 1	lb.	.23	.24
No. 2	lb.	.21	.23
Hematine	lb.	.08	.10
Crystals	lb.	.24	.34
Hypernic, liquid	lb.	.18	.20
Indigo, natural for cotton	lb.	.50	.54
For wool	lb.	.30	.32
Indigotin, 100 p.c. pure	lb.	—	5.50
Logwood, solid	lb.	.16	.19
Crystals	lb.	.19	.24
51° Tw.	lb.	.10	.14
Myrabolans, 25 p.c. tannin	lb.	.06	.07
Solid, 50 p.c. tannin	lb.	.10	.11
Osage Orange—			
Powdered, Aurantine	lb.	—	.25
Paste	lb.	.06	.12
Persian Berries	lb.	—	—
Quercitron	lb.	.06½	.11
Sumac, liquid, 25 p.c. tan	lb.	.06	.10½

DYEING ACCESSORIES.

Acetic acid, 28 p.c	lb.	.05¼	.05½
56 p.c.	lb.	.11½	.12
Glacial, 99 p.c	lb.	.37½	.40
Albumen, Egg	lb.	1.00	1.05
Blood, imported	lb.	.55	.75
Domestic	lb.	.45	.50
Alum, ammonium, lump	lb.	.04¾	.05½
Alum, chrome	lb.	.18	.20
Alum, chrome potassium	lb.	.30	.32
Alum, chrome sodium	lb.	.12	.12½
Alum, potassium, lump	lb.	.06½	.07
Aluminum acetate	lb.	.95	1.00
Aluminum chloride, anhyd.	lb.	.35	—
Aluminum sulfate, techn	lb.	.02	.02⅛
Aluminum sulfate, iron free	lb.	.03½	.03¾
Ammonium vanadate	lb.	7.00	—
Bleaching Powder, 35 p.c	lb.	.01⅛	.01½
Borax, cryst.	lb.	.07½	.07¾
Citric acid, crystals	lb.	.72	.75
Powdered	lb.	.72½	.75
Copper subacetate (verdigris)	lb.	.40	.42
Copper sulfate (blue vitriol) 99 p.c.	lb.	.09½	.10
Dextrine, corn	100 lbs.	—	5.90
Dextrine, imported potato	lb.	.13	.14
Dextrine, domestic potato	lb.	.09	.10
Ferric sulfate, basic (nitrate of iron), comm.	lb.	.02½	.03
True		.05	.06
Ferrous acetate (pyrolignite)	lb.	—	—
Ferrous sulfate (copperas)	100 lb.	1.00	1.50
Formic acid, 75 p.c	lb.	.35	.40
Glauber's salt (sodium sulfate)	100 lb.	.70	.75
Glucose	100 lb.	2.50	2.55
Glycerin, C. P.	lb.	.64	.64½
Gum arabic, firsts	lb.	.45	.50
Seconds	lb.	.36	.40
Sorts, amber	lb.	.29	.32
White	lb.	.35	.36
Gum tragacanth, Alep., firsts	lb.	2.28	2.37
Seconds	lb.	1.94	2.00
Thirds	lb.	1.65	1.85
Sorts	lb.	.75	.90
Hydrochloric acid (muriatic) 18°	lb.	.01¼	.01½
20°	lb.	.01¾	.02
22°	lb.	.02	.02¼
Lactic acid, 22°	lb.	.05½	.06½
44°	lb.	.14	—
Nitric acid, 36°	lb.	.05¾	06¼
38°	lb.	.06¾	.07¼
40°	lb.	.07	.07⅛
42°	lb.	.07⅛	.07½
Oxalic acid	lb.	.47	.48
Potassium antimony tartrate (tartar emetic)	lb.	.57	.59
U. S. P.	lb.	.62	.64
Potassium bichromate	lb.	.36	.37
Potassium ferricyanide (red prussiate)	lb.	2.75	2.90
Potassium ferrocyanide (yellow prussiate)	lb.	1.08	1.10
Potassium tartrate, acid (cream of tartar)	lb.	.48½	.49
Prussian blue	lb.	.80	.90
Soluble	lb.	.95	1.00
Sago flour	lb.	.04¾	.05
Soda ash, 58 p.c	100 lbs.	2.85	3.05
Soda, caustic, 76-78 p.c.	100 lbs.	7.20	7.30
Sodium acetate	lb.	.09½	.10
Sodium arsenate	lb.	.25	.60
Sodium bichromate	lb.	.15¾	.16
Sodium bisulfite	lb.	.05¾	.06
Sodium chlorate	lb.	.23	.24
Sodium ferrocyanide (yellow prussiate)	lb.	.34	.38
Sodium nitrite techn	lb.	.34	.38
U. S. P.	lb.	.38	.42
Sodium phosphate, com	lb.	.06	.07
Sodium silicate, liquor 40° p.c.,	100 lbs.	1.05	1.25
Crystals	lb.	.02¼	.02½
Sodium sulfide, 60 p.c., fused	lb.	.03	.03¼
Crystals, 30 p.c.	lb.	.02	.02¼
Sodium Thiosulfate (hyposulfite)	100 lbs.	1.60	1.75
Soluble oil, 50 p.c.	lb.	.10	.12
75-85 p.c.	lb.	.14	.16
Stannous chloride (tin crystals),	lb.	.40	.40½
Stannic chloride (tin bichloride), 50°	lb.	.19¾	.20¼
Starch, corn, pearl	100 lbs.	6.05	6.18
Potato	lb.	.12½	.13
Rice	lb.	.08	.10
Wheat	lb.	.05	.06
Sulfuric acid, 60°	ton	21.00	23.00
66°	ton	33.00	36.00
Oleum, 20 p.c.	ton	8.00	40.00
Tartaric acid, crystals	lb.	.78½	.81
Turkey Red oil	lb.	.14	.16
Zinc dust, 350 mesh	lb.	.18	.25

IMPORTS AND EXPORTS OF COAL-TAR PRODUCTS AND NATURAL DYESTUFFS

The following is the Government report of imports and exports of these wares for the ten months ending April, 1915, 1916, and 1917, and for the month of April, 1916, and 1917.

IMPORTS

ARTICLES	APRIL				TEN MONTHS ENDING APRIL					
	1916		1917		1915		1916		1917	
Coal-tar products:										
Alizarin and alizarin dyes........lbs.	435	$1,148	761	$1,357	5,991,653	$1,585,978	16,055	$14,253	38,778	$64,393
Carbolic acid........lbs.	251,318	15,935	41,790	2,724	2,995,864	170.048	1,688,095	114,052	707,300	50,443
Colors or dyes........	......	345,227	......	236,531	......	5,736,243	......	2,708,063	......	2,651,521
Imported from—										
Germany........	......	......	......	......	......	4,240.295	......	849	......	463.050
Switzerland........	......	107.980	......	171.343	......	880,552	......	766,670	......	1,571.151
United Kingdom........	......	61 750	......	58,789	......	145 809	......	180,382	......	457.470
Other countries........	......	175,497	......	6.399	......	469,587	......	1,760 162	......	159,850
Dead or creosote oil........gals.	5,657,982	436,793	245,588	21.557	25,434,245	1,592,310	35,133,006	2,826,010	28,713,642	2.151.157
Indigo, synthetic........lbs.	......	......	83,548	48 200	......	......	......	......	[1]658,804	[1]439,024
All other coal-tar products.. free	......	83,471	......	65.917	......	227,972	......	345.992	......	553,169
dutiable	......	49,691	......	27.252	......	590.536	......	385,299	......	477,601
Gambier........lbs.	582.800	46,468	724,209	65,118	13,141,167	498 929	9,899,737	671.096	7.456.847	553,078
Indigo, natural and synthetic........lbs.	473,147	969,896	......	......	7,693,382	1,222,785	5,601,481	6,014,860	[2]537.412	[2]960.038
Natural........lbs.	......	......	110,085	228,846	......	......	......	......	[1]746,003	[1]1.453.638
Dyewoods, in a crude state:										
Logwood........long tons	13,572	470.420	5,193	123.025	42.297	570.041	73.674	1,362,791	113.094	3.865.934
All other........long tons	1,292	30,725	665	28,792	6,889	103,359	21.564	384,318	7,797	159.897
Total........tons	14,864	501,145	5,858	151,817	49,186	673,400	95,238	1,747,109	120,891	4,025,831
EXPORTS										
Dyes and dyestuffs........	......	$637,445	......	$1,345,704	......	$824,290	......	$3,404,327	......	$8.6832,39

Note.—[1]Imports beginning September 9, 1916, when the present tariff act came into force. [2]Imports prior to September 9, 1916.

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By Carleton Ellis and A. A. Wells.[*]

This Is the Sixth Installment of an Article Dealing with Investigations Conducted by the Writers Into the Possible Application of Ultra Violet Light. The Present Installment Continues a Discussion of the Effectiveness of Its Rays for the Sterilization of Liquids as Compared to Ozone. Various Forms of Apparatus Are Also Described. Part VII Will Appear in the Next Issue.

PART VI

STERILIZATION OF LIQUIDS.

Ultra Violet Rays vs. Ozone.

Erlwein (J. Gasbeleucht, 1911, 54, 955; J.S.C.I. 1911, 1228) has made comparative experiments on the efficiency of many forms of lamps for producing ultra violet rays for sterilizing water, and states that none were found to be satisfactory; nor did the admission of air with the water lead to the formation of ozone or increase the sterilizing effect. The least consumption of energy was found to be given by a sterilizer in which the quartz mercury lamp was suspended in the axis of a swinging cylinder through which the water passed with a tangential motion. When this method was compared with the ozonization process, it was found that, to produce the same bactericidal effect on the whole of the water supply of Marseilles, the use of ultra violet rays would require an installation of 540 kilowatts and the ozone method an installation of 100—109 kilowatts. A drawing is given of a particular form of ozonizing apparatus made for domestic sterilization purposes in which the energy consumed varies from 10 to 60 watt hours according to the concentration of ozone required. The ozone method has the further advantage that a simple chemical test with iodide and starch applied to the treated water will show at once the efficiency of the process, instead of having to wait for some days for the result of a bacteriological cultivation test.

Production of Ozone.

A sterilizing apparatus used by *Jaubert* (French patent 415,574, July 19, 1909) consists of a horizontal quartz mercury vapor lamp surrounded by a jacket. The liquid to be sterilized is caused to circulate through the space between the lamp and the jacket. The liquid should contain air or oxygen in solution or suspension, so that ozone is formed when the liquid is subjected to the action of the ultra violet rays emitted by the lamp.

Use of the Photometer.

In the process of *Doulhet* (French patent 458,167, April 28, 1913) the lamp is placed in the center of the liquid to be sterilized and may be surrounded by a quartz jacket in order that it may be operated at a high temperature. If the lamp is placed directly in the liquid, metal supports are provided at the ends so that the electrodes are not cooled. A photometer, depending on the principle that ultra violet rays pass through quartz but not through ordinary glass, is used to ascertain whether the rays are traversing the liquid thoroughly. Baffle plates in the sterilizing chamber cause the liquid to flow in close contact with the lamp. The liquid, if opaque and containing fat globules, may be diluted with water before being passed through the apparatus, and concentrated subsequently under reduced pressure, or the sterilization may be carried out at such a temperature that the fat globules are melted.

Sterilizing Apparatus.

Von Recklinghausen (U. S. patent 1,156,947, October 19, 1915) describes an apparatus for sterilizing liquids, which consists of a tank divided throughout the greater portion of its length into two main compartments. One compartment is relatively shallow and near the top of the tank. In flowing from one compartment to the other the liquid passes over wiers or baffle walls in a thin stream and is exposed to the action of the light in thin films. The ultra violet light is located just above these baffle walls.

Walkley and Tubex Engineering Co., Ltd. (British patent 14,689, June 18, 1914) have devised an apparatus for the sterilization of liquids. The liquid is passed as a thin film over the inner surface of corrugated plates which are curved so as to form a cylindrical vessel inside of which the lamps emitting ultra violet rays are suspended. The plates may be curved in various shapes.

Apparatus for sterilizing water by means of ultra violet rays described by *Nogier* (French patent 420,281, Nov. 18, 1909; English patent No. 9,960, April 20, 1911; J.S.C.I. 1912, 356) includes a sterilizing vessel consisting of two chambers connected by a narrow orifice. This orifice is traversed by the horizontal tube of a mercury vapor lamp, so that the water, in passing from one chamber to the other, comes in close contact with the tube, which is made of quartz or other substance transparent to rays of short wave length. The flow of water through the sterilizing vessel is controlled by a device installed in the electric circuit. This device includes a cylinder provided with an inlet and an outlet for the passage of the water, and with a piston. A rod with a conical end projects downward from one side of the piston, and a pillar of soft iron projects upward from the other side of the piston. When the electric current is switched off, a spring, acting on the piston, presses the conical end of the piston rod into the funnel-shaped mouth of the inlet so that the flow of water to the sterilizing vessel is arrested. When the electric current is switched on, the piston is drawn upward by an electro magnet of soft iron situated directly above the pillar before mentioned, and the water then flows to the sterilizing vessel at a rate which is proportional to the intensity of the electric current.

---

[*] All rights of publication in book form reserved by the authors, Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

In another apparatus proposed by Nogier (French patent 426,606, May 6, 1910) a circular tube is provided at intervals with partition plates or screens which alternately direct the current of water passing through the tube from the center to the periphery and vice versa. Quartz mercury lamps are situated in the tube between the partition plates and means are provided for introducing or removing the lamps without interfering with the flow of water.

In sterilizing liquids by means of ultra violet rays, *Linker* (U. S. patent 1,079,503, Nov. 25, 1915) recommends conveying the liquid to be sterilized through a central passage extending throughout the length of a mercury vapor lamp. One end of the tube is then turned backwards in the form of a spiral round the outer wall of the lamp. The tube is out of contact with the walls of the lamp and is sealed into each end of the passage so that a dead-air space is provided between the inner wall of the lamp and the tube.

In an apparatus for sterilizing liquids described by Kowalski (J.S.C.I., 1916, 379, British patent 1662, February 2, 1914) a guide wheel is placed across the passage through which the liquid flows and directs the liquid at an angle against the blades of another wheel, the axle of which is supported in the long axis of the passageway. The rotation of this turbine wheel gives an eddying motion to the liquid, which is then exposed to ultra violet light.

An apparatus of the Banque du Radium (French patent 426,277, April 29, 1910) consists of an arc lamp, or other lamp capable of emitting ultra violet rays, fitted at the top of a vessel into which the liquid to be sterilized is admitted. The supply pipe for the liquid is provided with a valve which is operated by an electro magnet in circuit with the lamp. When the lamp is working, the valve is opened and the liquid is admitted into the lower portion of the vessel through a central overflow pipe which contains a metal sieve. Should the electric current be interrupted, the valve is closed and its movement at the same time opens up communication between the vessel and a small drainage pipe so that the vessel is emptied and stagnant liquid does not collect when the lamp is not working.

In another apparatus of the Banque du Radium (British patent 15,010, June 27, 1911) the flat bottom of the apparatus is replaced by bottoms having the form of truncated cones, the angle at the summit of which is such as to enable the ultra violet rays to be more effectively utilized.

Use of Baffles.

Arrangements are described by Helbronner and von Recklinghausen (British patent 18,768, Aug. 9, 1910) for varying the rate of flow of a liquid in different parts of a conduit while the liquid is being subjected to the action of ultra violet rays. The portion of the liquid passing near the lamp may be caused to flow more rapidly than the more remote portions by placing suitable baffle plates in the conduit; these plates may have V-shaped pieces cut out of their upper edges or they may be perforated with holes of different sizes, the larger holes being at the top of the plates and the smaller ones at the bottom.

Special Forms of Lamps.

In another modification by Helbronner and von Recklinghausen (French patent 424,369, March 12, 1910) the lamp is movably suspended in a quartz chamber from which the air is exhausted, the liquid to be treated being directed against the sides of the chamber. The outlet pipe for the liquid is provided with a valve which is operated by the flow of the liquid and regulates the working of the lamp. The lamp may be removed vertically or horizontally from the lamp chamber. The liquid may also be passed through a tube containing an inner quartz tube in which is situated the lamp, or it may be circulated through a chamber containing a quartz tube in which an arc lamp is fitted. Means are also described for passing a current of water over the inner surface of the tube surrounding the mercury lamp. Lamps emitting ultra violet rays are also fitted inside quartz tubes extending from side to side of a closed chamber through which the liquid to be treated is passed.

Apparatus Using Rotating Cylinder.

Helbronner and von Recklinghausen (British patent 12,947, May 27, 1910) also propose to subject the liquid in the form of a thin layer on the surface of a rotating cylinder, to the action of rays emitted by a mercury vapor lamp which is situated close to a window in an outer casing which encloses the cylinder, or the lamp may be placed inside the cylinder if the latter be constructed of material which is permeable by ultra violet rays. In another form of the apparatus, the lamp is situated near an open end of the cylinder and reflecting surfaces are arranged so as to direct the rays to the periphery of the cylinder. An endless belt moving across the periphery of the cylinder or a syphon arrangement, may be employed for removing or periodically washing secondary products from the cylinder, the liquid being removed by a scraper and secondary roller, or by means of a jet of air.

Prevention of Leakage.

One form of apparatus proposed by Helbronner and von Recklinghausen (British patent 23,077, Oct. 5, 1910) has the lamp enclosed in a metal frame provided with quartz windows, the chamber thus formed around the lamp being supplied with air or other gas at a pressure slightly exceeding that outside the chamber when the latter is immersed in the liquid to be treated, thus preventing leakage of the liquid into the lamp chamber.

In another form of apparatus for sterilizing liquids von Recklinghausen (United States patent 1,204,721) proposes the use of an ultra violet lamp having the tube bent in the form of a U. The liquid to be sterilized is passed through a spiral column composed of quartz or similar material, the latter coil being in turn enclosed in another coil or in a water jacket in order to reduce the temperature of sterilization. Two or three modifications of this apparatus are shown. The advantage of an apparatus of this type is that equipment of comparatively small dimensions would be adequate for the efficient treatment of such amounts of water as might be used, for example, in households or offices for sterilizing water for drinking purposes.

Still another apparatus described by Helbronner and von Recklinghausen (British patent 30,397, Dec. 29, 1909) consists of a cylindrical chamber which is made in three sections and mounted horizontally. The two end sections are fixed, while the middle section may be rotated. The lamps employed are fixed to a central rod passing through the chamber. The liquid to be sterilized is admitted at one end of the chamber, the central section is then rotated rapidly so as to cause the liquid to recede from the lamps and form a layer round the walls of the section, leaving a space between the lamps and the inner surface of the liquid. Instead of rotating the section, a propeller may be provided in the chamber to attain the same object. If a sufficiently high speed be imparted to the liquid, the pressure in the space between the lamps and the liquid will be practically nil, but with a lower speed, air may be admitted to fill the space. The liquid leaves the apparatus at the end opposite to the inlet. The apparatus may also be mounted vertically.

Henri Helbronner and von Recklinghausen (United States patent 1,151,267, August 24, 1915, and 1,193,143 August 1, 1916) describe an apparatus for treating liquids such as water which consists in a series of drawers or trays arranged in a zig-zag manner which allows an apparatus of comparatively small size to expose a large amount of water to the action of the light derived from a single lamp. It is also proposed to pass the water during the sterilization period through a series of drawers, a part of which are exposed to the light and a part being kept entirely dark. It is claimed that the best effects were obtained when the liquid was exposed for only about one-fourth of the time of its total passage through the apparatus.

For treating water and other liquids with ultra violet light, Henri, Helbronner and von Recklinghausen, (United States patent 1,150,117, August 17, 1915) describe a process for controlling the amount of liquid to be passed through the sterilizing chamber. For example, if the lamp becomes extinguished for any reason, the water is shut off, or on the other hand when the lamp is first started it takes some little time before it has reached its full power. In this case the water is allowed to flow slowly when the lamp is first put in operation, the rate of flow increasing until the control valve becomes wide open when the lamp has reached its maximum efficiency.

Sterilization of Milk.

For treating liquids which are rather opaque to the ultra violet rays, Henri, Helbronner and von Recklinghausen, (United States patent 1,068,898, July 29, 1913) propose the use of a rotating wheel or band to carry very thin films of liquid for exposure to the action of ultra violet light. In treating milk, it is stated that where the scraper removes the liquid from the roller after being treated, particles of butter are quite likely to be formed and these may cause difficulty later. Several modifications of scrapers, rollers, etc., to remove these particles of butter are shown. In one case the milk is removed from the roller by a jet of air, it being claimed that in this case no butter is formed. It is also proposed to use a second cylinder rotating in the opposite direction for removing the milk after sterilization.

Further modifications of apparatus for treating milk and other liquids are described by Henri, Helbronner and von Recklinghausen (United States patent 1,052,818, Feb. 11, 1913) in which the roller picks up a thin film of liquid, exposes it to the action of ultra violet light and in turn delivers it to a second roller, which gives it a further exposure. It is also proposed to arrange these cylinders in a gradually descending plane and then to expose in a gradually rising plane until the sterilized liquid is delivered at a point approximately equal to the point of entry. In such an apparatus the lamp is located in the center of this V-shaped receptacle, whereby its full efficiency is obtained.

Various other forms of apparatus are described by Helbronner and von Recklinghausen (British patent 12,948, May 27, 1910, and 18,458, Aug. 4, 1910) for treating opaque liquids with ultra violet rays, the essential feature of each modification of the apparatus being that the liquid is caused to pass before the lamp in the form of a thin layer. For this purpose the liquid may be passed through a shallow channel or tube, preferably of circular cross section, the lamp being suspended in the center of the circular vessel. The side of the channel opposite the lamp is constructed of quartz or of glass which is permeable to the rays. This side of the channel may be cooled by means of sprays of water. The cooling may also be effected by filling the space between the lamp and the channel with water. The liquid may be passed between plates which are permeable to the rays, or a number of flat channels may be employed.

In a process for sterilizing liquids, Henri, Helbronner and von Recklinghausen (United States patent 1,124,737, January 12, 1915) expose the liquid to be treated in thin films, which are produced by the force of adhesion. It is claimed that opaque liquids similar to milk do not form sufficiently thin films to enable them to be efficiently sterilized when the force of gravity alone is relied upon to produce the films. In the apparatus described a thin film liquid is caused to travel upward on the inside of a hollow cylinder within which the ultra violet lamp is located. The liquid is delivered into this exposure chamber from a series of jets near the bottom of the cylinder. The latter is rotated in such a manner as to carry the thin film around the periphery and the film is scraped off upon completing the circuit. A device to cool the sterilized liquid is used in connection with the scraper.

(To be continued in the September issue.)

Addresses to Feature Chemical Exposition Week of September 24

Manufacturers, works managers, chemists and engineers all over the country are taking a very active interest in the Third National Exposition of Chemical Industries to be held in the Grand Central Palace, New York, week of Sept. 24, 1917.

The success of the former Expositions have been heralded in European countries. This has stimulated these countries to seek a better knowledge of the remarkable growth of the American Chemical Industries.

The U. S. Government, through the Bureau of Soils, will be represented and will have an exhibit illustrating the fertilizer situation, and more especially American sources of potash.

The program of the Exposition in part in the last issue bids fair to attract much attention. In one phase it will discuss the foreign trade opportunities that the American manufacturer now has presented to him, and how to gain and hold those markets. Another phase of the program covers the work of some of war councils. It will be remembered that at the first Exposition Mr. Howard Gross was one of the speakers and there proposed a Governmental Tariff Commission; the appointment of that committee by the President is but one of recent moment and it is an interesting thing to learn how that committee will operate. Dr. Grinnell Jones, of Harvard University, who has been selected as Chemist to the Commission, will be one of the speakers. It is not unlikely that Dr. F. W. Taussig, the chairman of the Commission, will be another speaker to enter into the national operation of the Commission for all the industries, while Dr. Jones' discussion will be confined to the chemical phases of the Commission's work. It is certain that these addresses will be of great importance to the Chemical industries, supplying them with much valuable information as to what they may expect, and as to how they could assist the Commission making its work more thorough, to have a stimulating effect upon the productiveness of the American Chemical Industry.

There will be a symposium upon the national resources where men thoroughly familiar with them will discuss their opportunities and how great industries can be built therefrom.

The tentative program as now set forth is as follows:

Monday, Sept. 24th—Opening Day.
  Opening addresses by Dr. C. H. Herty, Dr. Julius Stieglitz, Prest. American Chem. Soc.; Dr. C. G. Fink, Prest. Amer. Electrochemical Soc.; Dr. G. W. Thompson, Prest. Amer. Inst. of Chemical Engineers.
Tuesday, Sept. 25th—
  Prof. M. T. Bogart, Chairman, Chemical Committee, National Research Council, "The Operation and Work of the National Research Council for the National Weal."
  Dr. Grinnell Jones, "The Tariff Commission and Its Operation With Reference to the Chemical Schedule."
Wednesday, Sept. 26th—
  W. S. Kies, Vice-President National City Bank, "The Development of Export Trade With South America."
  Dr. L. H. Baekeland, Naval Consulting Board, "The Future of the American Chemical Industry."
  Meeting of the Technical Association of Pulp and Paper Industry.
Thursday, Sept. 27th—
  Symposium on National Resources for Chemical and Allied Industries, participated in by
  Mr. C. H. Crawford, Assistant to President of Nashville, Chattanooga & St. Louis Ry.
  Mr. V. V. Kelsey, Chemist-Industrial Agent, Carolina, Clinchfield & Ohio Ry.
  Dr. E. A. Schubert, Mineralogist-Geologist, Norfolk & Western Ry.
  Dr. T. P. Maynard, Mineralogist-Geologist, Central of Georgia Ry. and Atlantic Coast Line Ry.
  Dr. J. H. Watkins, Geologist, Southern Ry.
  Meeting of the American Institute of Chemical Engineers.
Friday, Sept. 28th—
  Meeting American Chemical Society, New York Section. Papers to be announced later.

The motion picture program will be announced later, though the following firms have placed their films at the use of the exposition managers: The American Cyanamid Co.; Barber Asphalt Paving Co.; E. I. DuPont de Nemours & Co.; General Electric Co.; Eagle-Picher Lead Co.

THE CHEMICAL ENGINEER

VOL. XXV. AUGUST, 1917 No. 6

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, AUGUST, 1917

Coal-Tar Chemistry 201
Edited by Thomas H. Norton, Ph.D., Sc.D.

Under which is included:

EDITORIALS:

The Organization of National Industrial Research 201
A New Factor in the American Dyestuff Industry 204
Government Activity in the Field of Color...... 205
Phenol from American Coal-Tar.............. 206
Annatto from Porto Rico..................... 206
The American Supply of Toluene............. 207
Situation of the Leading German Artificial Color Company 208
Export Licenses 208

COAL-TAR CRUDES:

The Determination of Phenol in Crude Carbolic Acid and Tar Oils......................... 209
John Morris Weiss and C. R. Downs.

COAL-TAR INTERMEDIATES:

Differentiation of the Two Naphthols by the Aid of Sulfotitanium 220
Manufacture of Phosgene................... 220
Quantitative Estimation of Picric Acid........ 220
3-Nitro-1-amino-benzene-6-sulfonic Acid 220
Aromatic Amido-Oxy-Compounds 221
Amino-anthraquinone 221
An Improved Method of Separating Sulfonic Acids 221

ARTIFICIAL COLORS:

The Evolution of Coal-Tar Colors............ 221
The Physical Basis of Color Technology........ 223
Government Control of the British Dyestuff Industry 224
A New Class of Yellow Azo Colors........... 224
A New Series of Sulfur Yellows.............. 224
New Azo Colors for Use on Vegetable Fibers.. 225
Color Lakes Derived from Complex Tungstic Acids 225
New Wool Disazo Dyestuffs.................. 226
The Use of Phosphomolybdic Acid in Producing Color Lakes 226

NATURAL DYES:

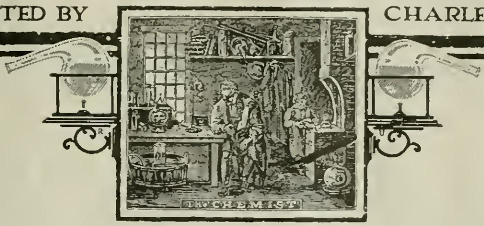
The Art of Dyeing 227
Clement Bolton.
Color Trade Journal, Vol. 1, No. 1, August, 1917. 229
Disastrous Conflagration in the Factory of the Seydel Manufacturing Co.................. 230
Explosion in the Beckers Works.............. 230
Explosion in the Works of the Midvale Co...... 230

CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS:

Crudes, Intermediates and Explosives, Synthetic Medicinals, Flavors and Perfumes, Photographic Developers, Artificial Colors......... 230
Natural Dyestuffs, Dyewoods and Raw Materials, Extracts, Dyeing Accessories................ 231
Imports and Exports of Coal-Tar Products and Natural Dyestuffs 231
Ultra Violet Light: Its Application in Chemical Arts. Part VI.......................... 232
Carleton Ellis and A. A. Wells.
Addresses to Feature Chemical Exposition of September 24 235
Table of Contents.......................... 236
Chemical Investigation, Efficiency and Control... 237
Conducted by Charles B. Davis.
Distillates: News Notes of Chemical and Allied Industries 238
Foreign Trade Opportunities 239
August Prices of Chemicals, Etc.............. 240

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS. F.C.S.



ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

A. S. T.—Your inquiry regarding Argon has been looked into very carefully, and I am in a position to report as follows:

Discovered by Rayleigh & Ramsay in 1894.

Vapor density (0-16)	19.67
Atomic weight	39.90
Condenses to colorless liquid and boils at	—186.90
Air contains—volumes	0.9

By cooling with oxygen at 50.6 atmospheres it solidifies.

Removed from nitrogen by passing over red-hot magnesium, which absorbs the nitrogen and leaves the Argon.

Molecular Heat	2.50

which proves that Argon has only atom in its molecule and weighs 40.0.

	*Helium	Neon	ARGON	Krypton	Xenon
Density	1.98	9.97	19.96	40.88	64.
Atomic Weight	4.0	20.0	39.9	81.8	128.0

(All five discovered by Ramsay.)

W. B. P.—The sample of maple syrup taken by me from your manufacturers' last shipment gave the following results upon chemical analysis:

	per cent.
Solids by refraction	68.00
Polarization direct (V)	+57.00
Polarization invert (V26C)	—21.00
Polarization invert (V87C)	0.00
Lead number	0.79
Ash	0.46
Reducing sugar before inversion	5.98
Glucose	0.00

These figures point to added cane sugar; therefore it is an adulterated article. The cane sugar has been added to lower, reduce, and injuriously affect its quality and strength. It is also misbranded for the reason that the article is an imitation of pure Vermont maple syrup.

M. C. S.—Your letter regarding the waste products you are sending me for analysis has been received. Just as soon as the samples arrive I will start the investigation to ascertain in what manner and what industries these materials can find a profitable outlet.

I would recommend that you read the article by G. R. Tuska on "Improvements in Waste Disposal Plants," in the Feb.-Mar. issue of this journal.

G. A. H.—The color of your starch is entirely due to its reaction. I also wish to draw your attention to its high content of moisture, which, if not reduced, will favor mould growth. I strongly recommend that you remove this moisture by a gradual increase of temperature so as to prevent gelatinization.

G. X. L.—You are adding too high a percentage of water to your white paint, which is greatly impairing its drying qualities.

You are perfectly correct in your preference for zinc white over lead oxid when used in chemical laboratory painting since the latter would rapidly discolor from the fumes.

M. I. O.—Aseptic autolysis of your beef during cold storage will not occur if you prevent bacterial action, and see that the most favorable conditions prevail. Autolysis is caused by the action of enzyms occurring naturally in the beef and mainly in the muscular tissue. If you will inform me just when it will be convenient to take the samples, I will proceed with the bacteriological control experiments and ascertain the direct cause of your trouble.

Charles B. Davis.

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail ar specifically requested, communications can only be considered in the order of their receipt.—Editor.

---

*Since it exists in the sun.

DISTILLATES

News Notes of Chemical and Allied Industries

$3,000,000 Chemical Corporation.

Under the laws of Delaware, the Virginia Consolidated Chemical Corporation has been incorporated with a capital of $3,000,000 to conduct chemical works of all kinds. F. D. Buck J,. D. Frock and K. E. Longfield are the local Wilmington, Del., incorporators.

Chlorine Products, Dyes, Chemicals, Etc.

The Virginia Chlorine Products Corporation has been incorporated under the laws of Delaware with a capital of $1,500,000, to manufacture all kinds of dyes, chemicals, etc. The incorporators are C. J. Kulberg, New York; H. Van Arsdale, Newark, N. J., and D. A. Woodcock, Passaic, N. J.

Chemicals and Dyestuffs.

With a capital of $200,000, the Consolidated Core and Chemical Co., Inc., has been incorporated under the laws of New Jersey, to manufacture chemicals and dyestuffs. C. F. Fuehrlein, 122 Hudson St., New York City, represents the new firm.

To Export and Import Chemicals.

The Orient Merchandise Company, Ltd., Manhattan, has been incorporated under the laws of New York to export, import and deal in chemicals. The capital is $25,000 and the incorporators are I. Bergman, F. Friedman and S. R. Rhodes, 38 Park Row, New York City.

Will Deal in Chemicals.

The Thomas & Betts Company, Elizabeth, N. J., has been incorporated under the laws of that state with a capital of $300,000, to act as merchants and deal in chemicals. The incorporators are Robert McK. Thomas, Mendham, N. J.; Hobart D. Betts, Englewood, N. J., and Adnah McMurtrie, New York City.

Tanning Firm Incorporated.

The Alliance Commercial Company, Inc., Manhattan, has been incorporated to carry on a business in hides, skins, leather and as tanners. The capital is $5,000 and the incorporators are M. S. and R. Reiler and M. Spiro, 448 Fifteenth St., New York City.

Coloring Matter for Brewing.

24803—An association in England wishes to purchase malt, barley, glucose, chocolate in bars, beer in casks and bottles, coloring for brewing, milk in tins, and fodder for cattle. Quotations should be made c. i. f. French or British ports, also c. i. f. Haifong, French Indo-China. Payment will be made by cash against documents. Reference.

Drugs and Chemicals.

The Warren Products Co., Inc., Manhattan, chemicals and drugs, has been incorporated under the laws of New York, with a capital of $10,000, by F. L. Cramer, O. K. Hill and H. R. Harrison, 120 Broadway, New York City.

Chemicals and Medicinals.

The Lister Aseptic Company, Manhattan, has been incorporated under the laws of New York, with a capital of $5,000, to manufacture chemicals for medical and other purposes. The incorporators are J. H. Deats, R. Reed and W. Wilson, 89 Macon St., Brooklyn.

Glue, Gelatine and Mica.

National Gelatine & Glue Works, Inc., New York City, has been incorporated with a capital of $5,000 to manufacture glue, gelatine and mica. The incorporators are A. J. and W. Alexander, 229 West Ninety-seventh Street.

Fertilizer, Ammonia and Greases.

Fertilizer and a number of other by-products, which include ammonia and greases, and bone-charcoal for sugar-refining, will form the regular output of the brick and steel chemical plant to be erected, at a cost of $51,000, by the Texas Chemical Company, Houston, Texas.

Largest Paper Mill to Be Erected.

The erection of the largest paper mill in the United States is contemplated by the Sound Paper Company, Seattle, Washington, which was recently incorporated with a capital of $6,000,000. It is estimated that $10,000,000 will be required to build the plant, and as much again for the development of the Sultan water power project, which the city of Seattle has granted the company permission to carry out.

Will Manufacture Coal-Tar Products.

The West Coast Chemical Company, Seattle, Washington, is seeking 25 to 50 acres of land for the erection of a plant for the manufacture of coal-tar products.

$4,000,000 Alcohol Corporation.

The International Alcohol Corporation has been incorporated under the laws of Delaware with a capital of $4,000,000 to manufacture alcohol from sawdust, wood waste, celluloid and other substances. Lewis F. Rebore, Frank Cusick and A. Sheard, all of New York, are the incorporators.

FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Fumigating Apparatus; Paper Towels.

23944.—A firm in Canada is in the market for hand and small portable spraying devices for oils, liquid-soap dispensers, disinfecting devices and deodorizers, fumigating apparatus and materials, and folded paper towels. Quotations should be made f. o. b. port of shipment. Correspondence may be in English. Reference.

Washing Soda and Soap.

24082—A firm in Dutch Guiana, with representatives in the United States, desires to receive quotations from American manufacturers and exporters of green or soft soap in two and one-half to three-pound bars, and washing soda.

Medium Priced Writing Paper.

23948.—A merchant in British East Africa wishes to buy medium priced ruled paper in pads of 100 sheets; about 50 gross pads are needed annually; about 3,000 reams of ruled legal cap writing paper; about 20,000 packages of note writing paper, 100 sheets to a package; about 50,000 thin blue and white envelopes; and about 300 gross of large and small copying pencils. Quotations should be made c. i. f. destination. Payment will be made by sight draft. Goods should be packed in extra strong waterproof cases. Correspondence may be in English. Reference.

Soaps.

24050—A firm in British Guiana is in the market for all kinds of soap, especially low and medium priced laundry soap. It also desires to entertain an agency proposition. Quotations should be made f. o. b. New York. Terms desired are 60 days' credit or draft against documents. Correspondence may be in English. Reference.

Sulphite Pulp.

24563.—A man in Italy wishes to purchase 1,000 tons of bleached and 2,000 tons of unbleached strong, fibered sulphite pulp, perforated dry, 10 per cent. air moisture. Quotations should be made c. i. f. destination per ton of 1,015 kilos. Payment will be made by bank credit. The pulp should be baled and wrapped with jute. Correspondence may be in English. Reference.

Oils, Drugs and Chemicals.

24778—A company in Sweden desires to be placed in communication with American manufacturers and exporters of raw materials for the textile, soap, paper, and margarine industries, cotton, wool, rubber, oils, metals, coffee, cocoa beans, spices, dried fruits, sirups, glucose, grain, mill products, lard, tallow, chemicals and drugs, resin, shellac, paraffin, raw hides and leather for shoe manufacturing, yarn, thread, wool, linen and cotton cloths, knit, tricot, and hosiery goods, novelties, automobile tires, etc. References.

Dyes, Oils and Varnishes.

24822—Quotations are desired by a firm in Italy for dyes, oils, varnishes, etc. A complete list of goods desired may be had on application to the Bureau or its district offices. Correspondence may be in English. Reference.

Aniline Oil; Coloring Substances.

24906.—Purchase is desired by a man in Italy of coloring substances generally, including aniline oil; leather for shoes (soles and uppers), and leather for automobile upholstering. An agency for these goods is also desired. Correspondence must be in Italian, Spanish, or French. Prices must be quoted to include packing, net weight, in Italian lire. Reference.

General Chemical Products.

25000.—Chemical products are desired by a large firm in Italy. A list of the chemicals desired and other information may be had on applicationt to the bureau or its district offices.

Carbolic Acid, Formaldehyde, Etc.

25210.—An agency is desired by a man in Italy for the sale of chemical and pharmaceutical products, especially carbolic acid, formaldehyde, salicylate salol, etc.; groceries, cocoa and cocoa butter, and mineral oils. Correspondence should be in Italian or French. References.

Chemical Products and Drugs.

25049.—A man in Guadeloupe desires to be placed in communication with manufacturers of chemical products and drugs. Correspondence should be in French.

AUGUST PRICES OF CHEMICALS, ETC.

For Prices of Coal-Tar Derivatives See Page 230

Acetone	.33	.35
Acid, acetic, 28%	5.02½	—
Acetic, 56%	10.05	—
Acetic, glacial	.40	.50
Boracic, crystals	.13¼	.13½
Boracic, powdered	.13	.13½
Carbolic, cans	.44½	.45
Chromic, tech.	1.20	1.25
Chromic, U. S. P.	1.25	1.50
Citric, crystals	.70	.72
Cresylic, 95%	1.10	1.15
Hydrochloric, 18°	1.50	1.75
Hydrochloric, 22°	2.00	2.25
Hydrocyanic, dilute, 3%	.20	.22
Hydrofluoric, 30°	.05	.05½
Hydrofluoric, 52°	.10	.10½
Lactic, pure, 50%	.30	—
Lactic, tech., 50%	.09	—
Nitric, 36°	.06½	.06¾
Nitric, 38°	.06¾	.07
Nitric, 40°	7.36	7.50
Nitric, 42°	.08	—
Oxalic, crystals	.46	.46½
Phosphoric, 85%	.33	.37
Phosphoric, 87½%	.33½	.37½
Picric	.75	.85
Pyrogallic, resublimed	3.15	3.25
Pyroligneous, tech., gal.	.10½	.13½
Pyroligneous, pure, lb.	.05	.05½
Sulphuric, 60°	1.50	1.75
Sulphuric, 66°	1.75	2.00
Sulphurus	.03	.05
Tannic, U. S. P.	1.30	1.35
Tartaric, crystals	.78½	.83
Alcohol, denatured, bbls.	1.00	1.02
Alcohol, grain, 190, U. S. P.	4.28	4.30
Alcohol, wood, 97%	1.05	1.07
Alum, ammonia, powdered	.04⅞	.05⅛
Aluminum sulphate, technical	.02¾	.03
Ammonia aqua, 26°	.06¼	.06½
Arsenic, white	.16	.16½
Barium chloride	85.00	90.00
Barium sulphate, powder	—	—
Barium nitrate	.12	.13½
Borax, crystals, bags	.07¾	.08
Calcium peroxide	1.50	—
Calcium sulphate	.10	.20
Carbon bisulphide	.07½	.08½
Cobalt, metal, oz.	.32	—
Cobalt, sulphate	—	.50
Copper nitrate	.45	.50
Copper sulphate, powdered	.12½	.13
Formaldehyde, bbls.	.16½	.16¾
Glauber's salt, 100 lbs.	.65	.70
Glycerine, C. P., drums	.63	.64
Iodine, resublimed	3.50	3.55
Iron oxide	.13	.15
Iron sulphide	—	—
Potassium bichromate	.37	.37½
Potassium chlorate, crystals	.49	.53
Potassium cyanide, true	2.25	2.50
Potassium permanganate	4.00	4.25
Rochelle salts	.39	.39½
Sal ammoniac, white gran.	.14	.15
Soda ash, dense	.04¾	.05
Sodium acetate	.10	.13
Sodium benzoate	2.75	3.00
Sodium bicarbonate	.02	.03½
Sodium chlorate	.24½	.25
Sodium cyanide	.48	.50
Sodium nitrite	.30	.40
Sodium phosphate	.05	.06
Sodium salicylate	.85	1.60
Sodium silicate	1.75	2.00
Sodium sulphide	.02	.02½
Sugar of Lead, powder	.17	.18
Sulphur, commercial	3.25	3.50
Sulphur, flour	3.85	4.00
Sulphur, flowers	3.95	4.10
Tin bichloride	.19¾	.20¼
Tin, crystals	.40	.40½
Tin oxide	.64½	.66½
Zinc carbonate	.25	.27
Zinc chloride	.10¼	.11½
Zinc oxide	.16	.21
Zinc sulphate	.05½	.06

Essential Oils.

Almond, bitter	15.75	16.00
Amber, rectified	2.25	—
Anise	1.07½	1.10
Cassia, rectified	1.75	1.85
Cedar, leaf	.85	1.00
Citronella, drums	.56	.57
Cloves, bottles	2.40	2.50
Eucalyptus, American	.65	.67½
Geranium, Algerian	4.75	4.80
Lemon, grass	1.30	1.35
Limes, expressed	6.50	6.75
Mustard, artificial	22.00	26.00
Orange, Sicilian	2.85	3.00
Pennyroyal, American	1.65	1.85
Peppermint, cases	3.50	—
Rose, natural	22.00	—
Rose, synthetic	2.75	3.00
Safrol, drums	.40	.45
Sandalwood, E. Indian	11.25	11.50
Sassafras, natural	.75	.80
Thyme, white	1.35	1.50
Wintergreen, leaf	4.15	—

THE CHEMICAL ENGINEER

COAL-TAR CHEMISTRY

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors.
Synthetic Medicinals, Flavors and Perfumes. Explosives,
Photographic Developers.

Edited by
THOMAS H. NORTON, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

George H. Bruce, LL.B., Gold Leaf Manufacturing Co., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hebden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles.

H. Gardner McKerrow, of the Marden, Orth and Hastings Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

EDITORIALS

The Purity and Strength of American Artificial Colors.

It is an almost every-day occurrence to encounter, in the daily journals and in the textile trade press, paragraphs tending to lower in the general estimation the quality of American-made dyes. Here is a typical example:

> "In spite of the progress reported in the manufacture of fast dyes in this country, retail stores are receiving complaints almost daily in regard to garments that have been injured or wholly ruined by colors that would not stand washing. A recent case is that of an expensive wash silk waist that was trimmed with hand-embroidered designs in colors. The color of the waist 'stood up' all right under the laundering, but the hues of the embroidery yarns were so intermingled with it that the waist looked like a kind of modern Josephs' coat. In another case perspiration took the dye out of the lining of a piece of summer fur and transferred it to the neck and waist of the wearer with generally disastrous results. Complaints of 'fugitive' colors in children's garments are frequent."

It is a patriotic duty to protest against this tendency to belittle the quality of the artificial colors now made in this country.

It is well known to every tinctorial chemist, and probably to most American dyers, that the colors now made in the United States are neither better nor worse than the corresponding colors of German or Swiss origin. They are simply identical, as far as dyeing properties are concerned. They may contain per pound more or less of the distinct coloring principle in question than the brands of foreign make, to which our dyers were accustomed before the war, just as there is great diversity in the concentration of the different types of a given dye made by any foreign or domestic manufacturer.

In regard to fastness towards light, washing, etc., the inherent properties of any current color remain the same whether it is made in Europe or America. The leading, reputable firms, manufacturing dyes in this country, are as scrupulous in assuring the purity and correctness of the colors sold under given designations as are their European rivals.

The cause of the frequent complaints referred to above is the failure of dyers to make use of dyes guaranteed by firms of recognized standing.

The general public fails to grasp the fact that the great mass of artificial colors possess but relative degrees of fastness to light, to soap, to acids, etc.

They are sold for specific purposes with a full knowledge by both seller and consumer of the limitations under which any color labors.

It is the business of the dyer to employ only such colors as possess the requisite degree of fastness for the materials to be dyed, as normally there is no difficulty in this connection. With the still existing shortage of many dyes, not yet made in this country, there is a constant temptation to use colors of a more or less fugitive nature, in order to meet the demands of fashion. There is nothing wrong in this practice, if the purchasers of fabrics or articles so dyed are clearly and adequately informed of the lack of fastness, so that they may be upon their guard with regard to the use of the same.

In the interest, however, of the good name of our American dyes, a determined effort should be made to have the relative fastness of the colors employed upon textile fabrics and similar wares adequately indicated upon the same. When the struggle begins to maintain the credit of our domestic colors against the effort to supplant them by foreign makes—and the time may not be far distant—it will be a tremendous asset to have the ordinary consumer convinced, in advance, that American manufacturers can furnish just as reliable dyes as those made upon the banks of the Rhine.

Death of Adolf von Baeyer.

The death at Munich, on August 23, at the ripe age of 82, of Professor Adolf von Baeyer, robs chemistry of one of her foremost leaders, one who has conspicuously directed the course of evolution of the coal-tar colors industry.

Baeyer was born in Berlin, October 31, 1835, the son of General Johann Jakob Baeyer, of the Prussian army, distinguished in the geodesy of Germany, and the first president of the Geodetic Institute of Berlin, created in 1869.

His university studies were pursued at Heidelberg, Ghent and Berlin. At Berlin he took the doctor's degree in 1858. He had already begun to specialize in organic chemistry, then beginning to claim an increasingly independent status in the university curriculum, largely as the result of Liebig's pioneer work.

In 1860 he was admitted as docent in organic chemistry to the teaching force of the Berlin University, and shortly after extended his courses to the Gewerbeakademie. In 1866 his marked ability was rewarded by promotion to the rank of extraordinary professor in connection with which he later had charge of the courses in chemistry at the Kriegsakademie. His marriage to Lida Bendemann, daughter of a prominent mining director, took place in 1868.

During this period Baeyer's laboratory at Berlin became an active center of research, and attracted many bright young chemists. The problems of the aromatic series, and especially of its tinctorial compounds assumed a dominant position. It was under Baeyer's guidance, in 1868, that Graebe and Liebermann carried out their classic synthesis of alizarin, and simultaneously paved the way for the discovery and utilization of a host of anthracene derivatives.

The Franco-German war came, and ushered in a new German Empire. One of the immediate results of the annexation of Alsace was the decision to create at Strassburg a university of the first rank. Brilliant and promising men were called to fill the chairs. In 1872, Baeyer was made ordinary professor of chemistry. Students quickly thronged his lecture room and laboratory.

The stay at Strassburg was however somewhat brief. Justus von Liebig, reverently regarded as Germany's foremost chemist, passed away and his chair at the University of Munich became vacant. The choice of a successor fell upon Adolf Baeyer, and time has amply vindicated that choice. In 1875 he removed to Munich, where a magnificent, new and modern laboratory was constructed after his plans. Here his lifework was carried out, and here he died. Students came from all parts of the world to Munich, as freely as when von Liebig was the presiding genius. In 1885 he was raised to the ranks of the hereditary nobility, as was the case with Liebig before him. Honors were showered upon him from all sides, and his name was placed upon the rolls of numerous academies and learned bodies. In 1881, the Royal Society of London conferred upon him the Davy medal; the French Academy of Science made him a foreign member in 1886, and in 1905 he received the Nobel prize for chemistry.

The researches of von Baeyer were extremely varied and numerous. Over 300 studies were published by him in the *Annalen der Chemie* and in the *Berichte* of the German Chemical Society, in the development of which he was actively interested from its origin in 1869.

He may fairly be regarded as the leading chemist of his day in organic synthesis, and this was the dominant note of most of his investigations. Some of the lines which he pursued were remarkably prolific of results, and opened paths followed up by many of his contemporaries. This was in a marked degree the case with his studies on condensation products, especially of aldehydes with hydro-carbons and phenols. Otto Fischer's discovery, in 1877, of Malachite Green, for instance, was made in the Baeyer laboratory.

In this field von Baeyer's most notable services, and those with which his name will be most closely associated, were rendered to the coal-tar color industry.

In the discovery of the wonderful possibilities of the phthaleins as sources of tinctorial substances, he made it possible to create a group of coal-tar dyes, resembling the alizarin group, and the various vegetable colors, apart from indigo, in the absence of nitrogen in the molecule.

His discoveries, in 1871, of phenol-phthalein, of fluorescein or uranin, of coerulein and of gallein (obtained from pyrogallic acid and not a coal-tar derivative), were not only in themselves most valuable contributions, but they paved the way for others in the years immediately following to quickly enlarge the group. Noteworthy was the discovery by Caro in 1875, of eosin. In this latter case, and in other closely allied instances, the exhaustive theoretical studies of von Baeyer formed the fundamental basis for inventive skill to extend with certainty and with rapidity the scope of its efforts. In later days faster and almost equally brilliant azo colors have displaced for many purposes eosin and other members of the group. A considerable demand, however, still exists. The discovery and introduction into tinctorial chemistry of the phthalein colors will always be regarded as a notable milestone in the evolution of coal-tar chemistry.

Of still greater and more lasting value are the marvelous series of studies in which von Baeyer disclosed the chemistry of indigo. With the help of finely trained assistants, he traced all the relationships between the products of the decomposition of indigo and simple constituents of coal-tar. The transformations, by successive steps, of the latter to isatin and to indole were patiently worked out, and the constitution of the indigo molecule clearly shown. These studies lasted from 1865 to 1878. During this period, but in a much shorter period of time, Graebe and Liebermann in his laboratory effected the synthesis of alizarin and the manufacture of the artificial product was made a commercial success. The realization of the same problem in the case of indigo was beset by far greater difficulties. It was not until 1880 that von Baeyer perfected the various steps connected with the synthesis of indigo from o-nitro-cinnamic acid, and that he was able to present it as an industrial process and secure patents. Technically the method was a success, but it was not possible to reduce the costs of production to the point allowing competition with the natural product. A fundamental difficulty was the price, and the limited amount available at that time, of toluene, from which cinnamic acid could be manufactured. A vast amount of work still remained to be done. In 1890, Heumann introduced his synthesis, based upon the use of phenylglycocoll-o-carboxylic acid, and soon after it was found feasible to use cheap naphthalene instead of toluene as the initial material. By 1897 it was possible to introduce artificial indigo upon the world's markets, and at the opening of this century it practically dominated the situation. The famous "Badische Co." did much to bring about the successful result. Its facilities were placed at the service of Prof. von Baeyer for years, and its chemists elaborated and rendered practicable the many individual features of the synthesis. It is stated that the company expended, all told, upon artificial indigo about $5,000,000 before a single pound was placed upon the market.

While vast sums were thus sunk, and scores and scores of chemists contributed each their mite to the final success, the name of von Baeyer, will always be most closely associated with this great triumph of synthetic chemistry. His profound and varied studies revealed every feature of the problem to be solved, and he first bridged all of the intervening gaps between coal-tar and pure indigo, leaving to others to complete the more purely economic details.

During the later years of his life, stereochemistry attracted much of his attention. In this connection he advocated the "centric" view of the constitution of the benzene ring.

Von Baeyer was a man of imposing personality, and of numerous friendships. Many Americans and many English chemists were trained in his laboratories, and owe much to his inspiration and companionship. No public utterance has been made by him since the outbreak of the present conflict, but it has probably caused him many a heart-wrench, as it would to August von Hoffmann, had he survived to our day. Both were connected by a multitude of ties with the men of science in all lands.

Professor von Baeyer had three children, one daughter and two sons. Of the latter, one has devoted himself to medicine, the other to physics. It appears to be exceedingly rare in Europe for chemical ability of a high order to be transmitted from father to son.

Co-Operation in Research.

There is continued discussion in England of the need of a much greater degree of co-operation in the chemical industry than has hitherto been the case. It is felt by many that the efficiency of the industry, as a whole, has suffered seriously from the individualistic policy which has been so marked in the past.

The questions of analytical control and standardization, and especially the all-important matter of research, as ensuring future healthful progress and the ability to meet aggressive foreign competition, are frequent topics of debate at all gatherings of technical men.

At the recent annual meeting of the Society of Chemical Industry Mr. Herbert W. Rowell emphasized the value of such highly organized facilities as are now multiplying in the United States, dwelling especially upon the work of the Mellon Institute in Pittsburgh.

Mr. Rowell feels that the British coal-tar industry is bound to face both a commercial and a technical revolution after the war, and urges prompt preparation. His argument applies to certain conditions in the American industry, as will be seen from the following extract:

> If the coal-tar interests can have commercial agreements as to raw materials, sulphate of ammonia, and creosote, why not in standard tests and products and in research and development of the trade. The tar producers and manufacturers of crudes and intermediates could subscribe, say, in proportion to their capital or turnover, to institute a central laboratory and experimental works while control testing and efficiency of existing plant would remain a matter for the attention of the individual works. This laboratory could have two functions, one an analytical department for devising specifications and standard methods of analysis and acting as a referee laboratory for the trade, and the other a research department with an experimental works and staff of chemical engineers attached to it.
>
> The specifications and tests devised by the analytical department would be common property, and would link producer and consumer and would help stabilize the trade, while the results of experiments, patented processes and plant, and other profits of the research department would be the property of the subscribers to the scheme. If it were made into a limited company with a scale of payments to it for the use of ideas evolved, the commercial aspect of the laboratory could easily be solved.
>
> The central analytical laboratory idea offers no difficulty, the cost would be small, and the results

of distinct value, but unless the trade is closely allied by commercial agreements, then the question arises as to what work could be undertaken by a central research department. A phase of work of general importance in which business interests could not clash is in raising the demand for and consequently the price of tar products and in meeting competition from other trades and nations.

If a research department could make pitch equal to natural bitumen, tar oils into fuel, and lubricant equal to petroleum oils, or discover a use for creosote oil equal to the present demand for timber preservation—and these things are by no means impossible,—it would cover its cost many times over.

The tar works is the proper place in which to make dyestuff intermediates as it economizes capital, material, transport, and labor. Many concerns have now nitric acid, oleum, nitration, sulfonation, and acid recovery plants, and have only vague plans for their use after the war.

Chemical and chemical engineering research is necessary before these plants can be utilized and the intermediates trade developed. A central organization working for the trade in general would produce cheaper, better, and quicker results than a number of badly equipped laboratories inadequately staffed, which is the best for which we can hope if the home manufacturers indulge in civil war while the German gathers in the trade again.

Other matters of a non-competitive nature, which might be taken up are the carriage of dangerous goods, better and cheaper packages, safety measures against fire, explosion, and industrial disease, and fuel economy. If an organization got as far as this, it would certainly develop into a full combination of technical interests. It would follow that the methods of distillation and the value and composition of the tar produced, and the possibilities in blast-furnace, producer gas, and oil gas tars are matters for investigation of profit both to producer and distiller.

The time for organization is short, for we expect soon to bring this war to a successful end, and we cannot deprive Germany of her scientific brains and organizing ability. We have immediately to face a commercial war against countries like America and Japan, with capital, scientific organization, and business efficiency, and the issue rests mainly with the directors of our engineering, chemical, and textile industries.

We look for some help from Government departments and committees, from scientific societies, from preferential and protective tariffs, from pure research in the universities and better education, but if the manufacturers and particularly the average and small-sized works, do not evolve their own salvation by the prompt adoption of scientific research and control, coupled with scientific management and business methods, the issue is certain and disastrous.

Artificial Phenol.

Nothing contributes more to the general confidence in the ability of our American chemists to rapidly and successfully solve big problems than a glance backward over the establishment in this country, since 1914, of the manufacture of synthetic phenol on a gigantic scale. A score or more of large plants are now producing it regularly in great quantities, chiefly for use in the manufacture of picric acid for war purposes.

The pioneer in the industry, however, was Thomas A. Edison. He it was who first comprehended the situation, saw it in a correct perspective, and took the necessary steps to insure a supply for the nation's needs. We were consuming normally a considerable amount of phenol, chiefly as a disinfectant and for antiseptic purposes. There was a certain amount needed in the arts, notably for the manufacture of the records for phonographs, graphophones, and the like.

Every pound of the supply came from Europe. Once the war was fairly started, the available stock was quickly commandeered by the belligerent governments. The price in the United States mounted, in a short time, from 9 cents per pound to $1.50. Prompt action was needed unless a variety of interests should suffer seriously. It was the quick resolve of Mr. Edison to create the synthetic manufacture of phenol from benzene which relieved the situation. In a short time he had demonstrated the ease and relative cheapness with which the hydrocarbon can be transformed into phenol, and provided the requisite supplies for sanitary and hospital purposes. Then came the insistent demands from abroad for picric acid. American firms were able to enter upon contracts, duplicating in their works the finely perfected system for the synthesis of phenol, equipped early in 1915 at Orange, N. J., by the Thomas A. Edison Co.

To-day the works at Orange are furnishing regularly 3,000,000 lbs. of phenol each month. So completely has the process been standardized that Mr. Edison has no intention of abandoning it when the war ends and normal conditions return. He is confident that he can manufacture artificial phenol at a cost no higher than that involved in the separation of phenol from coal tar and its complete purification.

We have no reason to wonder that Mr. Edison was, almost automatically, made the head of the Advisory Committee, called into existence by the Secretary of the Navy, over a year ago, when the possibilities of war became evident.

Women and Dyestuffs.

In another column we give details regarding the discovery of a new vegetable coloring material by Mrs. E. O. MacDonald, of St. Regis Falls, N. Y. There is a somewhat unusual degree of interest attached to this discovery of the dyestuff in autumnal leaves. As far as we know it is the first recorded instance in which the world is indebted to a woman for enriching its list of colors, natural or artificial.

It is, of course, not improbable that women may have contributed largely, during the ages, to the detection of the tinctorial value of various barks, leaves, fruits, etc., from which coloring matters could be extracted to use on textiles, basket work, and the like. But here we witness a woman, and it is pleasant to add, an American woman, carrying out the entire sequence of operations involved in the discovery of a new dye, the observation of color being crudely imparted, the logical deductions as to its source and nature, the experimental separation of the coloring principle, the painstaking and exhaustive determination of the methods of successful application!

Chemistry is a science in which women have, thus far, contributed but little to the main lines of progress. A single chemical element has been discovered by a woman. This was radium, discovered by Madame Curie, of Paris, co-operating, it is true, with her husband, but recognized as fully his equal in all that pertains to the successful revelation of the nature and properties of the elusive element, and the painstaking victory over a multitude of complex difficulties.

No woman's name has been associated with any of our synthetic dyestuffs. Now that young women are found in such numbers in our chemical laboratories, and are doing such faithful work on chemical teaching staffs, it is to be hoped that some one will take up the investigation of "gold leaf," as Mrs. MacDonald's new color is termed, and work out its constitutional formula. This has been done for the more important natural colors. In two cases the determination of the constitution paved the way for the synthetic preparation of the dyestuffs, and the world was enriched by artificial alizarin and artificial indigo.

It is highly probable that we have here to do with a combination of tannic acid and an aromatic complex allied to quercetin, morin or fisetin.

The valuable work of Koptanecki, who has analyzed and synthesized several important vegetable colors, can well serve as a model in this field.

Swift Expansion of the American Manufacture of Coal-tar Colors.

In another section we reproduce in full a most interesting summary by the Bureau of Foreign and Domestic Commerce, showing the present status of the American dyestuff industry.

We have every reason to be proud of what has been done during the past two and a half years. The statistics, collected most carefully by the Bureau, show clearly that today we are manufacturing coal-tar colors in amount equal to our normal consumption of these products before the war. It is true that we are far from producing the variety, then currently consumed, but that will come in time. It is a grand achievement to have organized so rapidly the plant, equipment and operatives needed to accomplish this work, and it will ever rank among the conspicuous triumphs of American enterprise and technical effort.

Despite the shortness of the period in question there is every indication that the foundation of the new industry have been substantially laid, so as to assure its permanence and its healthful expansion. At first it has developed along lines of least resistance, producing those dyes most largely in demand, and yet involving a minimum of time and effort. Now, each day, almost, witnesses the addition to the list of colors based upon more complex processes of manufacture, and necessitating a higher degree of co-ordination on the part of all factors concerned. With each passing week it becomes possible to meet more exactly and adequately the needs of those consuming colors.

The entrance upon the field of powerful corporations testifies to the confidence felt by capital in the future of the industry. The steps taken by our educational institutions, to provide adequate training for those aiming to become color chemists, give hope that we shall soon have an ample staff of young Americans well equipped to join in the work of making our domestic dyestuff production a powerful factor in the nation's industrial life. Before long they should be able to make themselves felt in contributing distinctly and effectively to the evolution of coal-tar chemistry, and create in our country a recognized center for research and progress in this field of unlimited possibilities.

The Department of Commerce deserves a hearty recognition of its interest in this important question, and of its intelligent and earnest efforts to further in every possible way the magnificent work of American capital and chemical skill in adding a new asset to the nation's wealth.

The Swiss Color Industry.

The abnormal conditions during war time have served to bring out in bold relief the fine organization of the four great dyestuff companies at Basel, and the comprehensive character of their products. Their ability, despite the great difficulty in securing raw material, to export a considerable volume and variety of dyes to this country, as well as to France and Great Britain, has contributed notably to take the edge off from the shortage in artificial colors, felt in all countries formerly dependent upon Germany.

It now appears, according to Swiss journals, that the German dyestuff interests are making the attempt—unsuccessful thus far—to buy outright the works in Basel, and make them an integral part of the German combine. Such a move would mean much both at present and after the war. It is not surprising, therefore, to learn that propositions of a similar nature have been made by British interests. It would certainly be of incalculable value to the British color industry if it could in any way assure the co-operation, at least, of the Swiss industry in its effort to rapidly attain independence from foreign sources of dyes. Switzerland's color industry is based upon an enormous amount of technical and scientific accomplishment, undertaken in the face of serious rivalry, and under severe handicaps, for the little republic is practically destitute of all the raw materials required in chemical industries except salt—and ice! Relatively the Swiss have contributed as much, if not more, than the German chemists to the evolution of the artificial dye industry.

More than once it has been suggested that close co-operation between our American color companies and their Swiss colleagues might be of pronounced mutual advantage. As it is, much of what has been accomplished in our midst is due to the presence of individual Swiss chemists, engaged by those occupied in building up the American industry.

It is highly probable that Switzerland, in the future, even more than in the past, will be a center of active research, and contribute notably to the general progress of tinctorial chemistry. The war has levied already a heavy toll upon the young generation of chemists in Germany, who would naturally form the investigators and inventors of the immediate future. The continuity of research has, likewise, been most seriously interrupted, as the attention of trained experts has been diverted to other fields, with more imperative claims upon German skill and scientific attainment.

All of these circumstances, combined with the admirable organization of the Swiss universities, point strongly to a more pronounced position of leadership in the general evolution of the synthetic color industry, and a rivalry which will be increasingly felt by the hitherto so powerful German interests.

The Reliability of American Colors.

A recent statement by the Director of the Bureau of Engraving and Printing at Washington is full of encouragement to those engaged in building up our American artificial color industry. Hitherto the Bureau has been dependent upon German sources for the colors employed in printing postage stamps, bank notes, bonds, etc. With great difficulty and after much diplomatic negotiation, Director Ralph secured in 1916 a needed supply of artificial colors from Germany. At the time he publicly expressed his doubts of the ability of the young American industry to meet the rigid requirements of the Bureau. The chief trouble was found with the red lakes, of which great amounts are regularly consumed. Crudeness of tint and unevenness of color characterized the products then offered by American manufacturers. The prices quoted were, also, practically prohibitive.

All of this is changed in the short course of a year. Director Ralph now declares:

"We are able to get all the colors we want, and at reasonable prices. I feel that the United States has thrown off the humilitating cloak of dominance, particularly German dominance, and that hereafter we can make in this country all the dyes we need, in whatever quantities we need them and at prices that are fair."

In view of the fact that the chief difficulty a year ago was encountered with red lakes, obtained from aniline, his specific statement concerning this category is most satisfactory. He states: "I am particularly pleased with the reds we have been getting. I believe they are superior in tinctorial strength and in durability and will prove considerably cheaper than the German reds we have been using."

All of this shows that the problems connected with the expansion of our coal-tar color industry are not so complicated but that Yankee pluck, knowledge and skill can solve them, and without much expenditure of time.

One by one the important colors are being introduced and manufactured upon a large scale. The processes and the products are being standardized, and American consumers are rapidly becoming accustomed to the types and degrees of strength provided by American producers.

It will not be long before those dyes, of which relatively small amounts are required, will be tackled in the same manner and be enrolled among the lists of "American colors," of recognized reliability in domestic and foreign markets.

The New Location of the National Aniline and Chemical Co.

Early in August the offices of the National Aniline and Chemical Co., Inc., were removed from 100 William Street, New York City, to 244 Madison Avenue, where they occupy nearly three floors.

This removal is an indication of the general movement of the chemical and dye trade of New York City to locations much farther north in Manhattan than the district occupied for so many years. This movement has been expected ever since the leading textile firms have settled in the district on Fourth Avenue and adjacent streets near Madison Square. As the dealings of the trade are so largely with the textile interests, there is a mutual advantage in occupying the same territory. The "National" is well to the north of the textile center; possibly in the expectation that the latter will continue its northward movement. It is highly probable that its example will be gradually followed by the other prominent firms, catering to the needs of the dyer and finisher.

The well-known firm of Walter F. Sykes & Co., dealers in dyestuffs, representing in the United States the St. Denis Dyestuff & Chemical Co. (Poirrier), of Paris, has been dissolved by mutual consent of the partners. Mr. Walter F. Sykes continues the business at 85 Water St., New York City, and has a factory at Bayonne, N. J.

Dr. C. G. Storm has accepted a position as consulting chemist for explosives with the Ordnance Bureau of the War Department, at Washington. For over two years Dr. Storm has occupied an important post with the Aetna Explosives Co. Prior to 1915 he was connected with the Bureau of Mines, and specialized on coal-tar explosives.

COAL-TAR CRUDES

The Manufacture of Anthracene.

There is a very marked hesitancy on the part of American manufacturers of coal-tar products, in extending their operations to anthracene and its many important derivative colors, at the head of which naturally stands alizarin. It is true that the preparation of commercial anthracene is by no means as easy as the separation and refining of most coal-tar crudes. It is a branch to which special attention was devoted in England before the war, and anthracene was the one crude material for which German color firms depended to quite an extent upon a foreign source.

There are, however, no inherent difficulties in this connection which cannot be overcome by persistent and intelligent effort. The raw material for the production of anthracene we now have in abundance, and it is earnestly to be hoped that the output of the hydrocarbon will soon assume such adequate dimensions that the manufacture of alizarin and a large group of allied colors may be promptly undertaken.

In this connection we reproduce from "The Dyer and Calico Printer" a valuable study on the subject, which appeared originally in "La Revue des Produits Chimiques":

Anthracene was discovered in 1832 by Dumas and Laurent in the oils obtained by the distillation of coal tar, and anthraquinone in 1840 by Laurent through the action of nitric acid on anthracene. The technical importance of these products dates from the synthesis of alizarin in 1868 and the development of the manufacture of coloring matters derived from anthraquinone. These are of remarkable fastness.

England was at one time the great producer of anthracene as also of all other products derived from coal tar. Thus, in 1880, the German color works transformed into dyestuffs about 1,400 metric tons of pure anthracene, of which only 200 tons were produced in Germany, the rest coming from England.

Before the war, it is estimated that the German works annually consumed more than 6,000 tons of pure anthracene, of which 5,000 tons were produced in the country. The rest, 1,286 tons in 1913, was imported chiefly from England and a smaller part from France. The mines at Lens, as a matter of fact, were anthracene producers. Their output in 1907 was 1,444 tons of crude anthracene. The German importation rose in the same year to 2,418 tons of crude anthracene, valued at 257,000 marks.

It must be added that Germany possessed almost a monopoly of the colors derived from anthracene. Outside of that country the British Alizarin Company alone produced alizarin and some colors made from it. We do not know the extent of this production, but do not think that it was more than a tenth of the German production. It would correspond therefore to about 600 tons of pure anthracene. This amounted to about 7,000 tons of pure anthracene. As the price of the colors made from it was at least 6 francs per kilo, their value was at least 40.000,000 francs. As the anthracene was hardly worth more than three to four millions, the plus value resulting from the transformation of the hydrocarbon into coloring matters is very important.

To cover the French consumption it is estimated that approximately 300 tons of pure anthracene were needed. Anthracene itself has no industrial uses, it is always transformed into anthraquinone. As a rule, the coal-tar distillers isolate the anthracene, bring it to a certain degree of purity and then send it on to the color works, where it is refined and transformed into anthraquinone.

Anthracene Manufacture.

Anthracene is isolated from the anthracene oils, which, in the distillation of coal tar, pass over between 280° and 400° C. It has an average specific gravity of 1.1. These oils form 16 to 18 per cent of the weight of coal tar, and contain from 2½ to 3½ per cent of anthracene. This is equivalent to an average content of .6 per cent of anthracene in coal tar. This content is influenced by its origin, according to whether the coal tar has been obtained in gas retorts or in coke ovens.

The figures show that very large quantities of material have to be manipulated in order to obtain a relatively small yield. The work is not without danger. Acridine contained in the anthracene oils causes cutaneous eruption and inflammation of the eyelids. All contact with the substances in the course of manufacture must therefore be avoided, and the plant should be provided with mechanical means to this end.

The anthracene oils, still warm, are left to crystallize in becks, and crude anthracene of a greenish color separates out on cooling, in the proportion of 6 to 10 per cent of the weight of the oil. By draining, filtration, or centrifuging this is separated. It contains from 12 to 22 per cent of pure anthracene. It is concentrated by crystallization in solvent naphthas, boiling from 170° to 200° C. Solution is effected in a horizontal boiler with an agitator and a double jacket serving for the circulation of steam.

The solution thus obtained is forced by compressed air into a vertical boiler with an agitator, and provided with a double jacket in which cold water circulates. It is cooled to 40° C., then filtered in a filter heated by hot water. The solid residue is centrifuged or pressed in a hydraulic press.

On cooling the warm solvent from the filter a less pure anthracene separates out, and this can be worked up in a new batch. The naphtha is recovered by distillation. Instead of this solvent, naphthalene oil obtained in the crystallization of naphthalene may advantageously be employed.

By this treatment a product containing 42 to 48 per cent of pure anthracene is obtained. Coal tar from the coke ovens furnishes the 42 per cent anthracene, that from the gas retorts averages about 47 per cent. At the same time, it must be noted that to obtain as pure an anthracene as possible it is important to choose very carefully the best fraction of the anthracene oils for the purpose, and this is governed by the origin of the coal tar and its composition.

The oils separated from the anthracene, which still contain some of it in solution, are usually added to creosote oil, and serve for the impregnation of wood, and for enriching coal-gas. Their composition is very complex. They contain phenols, methyl-naphthalenes, acenaphthene, phenanthrene, chrysene, diphenyl, carbazole, and other coal-tar derivatives which are held in solution.

The anthracene obtained, according to this process, is the industrial product. There were formerly also 22 to 30 per cent anthracenes. The 40 to 50 per cent product is now the only one on the market.

Anthracene is tested by Luck's method. It is oxidized with chromic acid in glacial acetic acid solution, and the anthraquinone formed is weighed after purification with dilute alkali and fuming acid.

In addition to anthracene, the commercial product contains notable proportions of acenaphthene, fluorene, phenanthrene, and carbazole, and smaller quantities of methyl-anthracene; pyrene, chrysene, acridine, diphenylene oxide, and paraffins.

Carbazole has acquired a commercial value during the last few years for the preparation of the vat colors, and it therefore is extracted by appropriate methods.

It is to be noted that the presence of methyl-anthracene, except in traces, spoils the shade of the alizarins. Also the content of paraffins may render the product unsalable. These compounds, however, are not found in undesirable quantities, except when the product has been obtained from coal distilled in gas retorts.

This impurity is easy to detect. On sulfonation with sulfuric acid of 66° Bé. on the water bath the aromatic compounds become soluble in water. The paraffins are not attacked and separate on diluting the liquid.

Purification and Concentration.

The 40 to 50 per cent commercial product is not employed in this state, although it was used at the commencement of the artificial alizarin industry. It is brought to 95 per cent by concentration.

This is usually effected by means of solvents in which the anthracene is less soluble than the substances which accompany it. Pyridine and acetone, out of many solvents which have been proposed, have been found the most suitable. The use of pyridine is claimed in a German patent. The operation takes place in a jacketted boiler furnished with an agitator. Compressed air is used for introducing liquids. About 3,000 kilos of anthracene is put into the boiler, then 5,000 litres of crude pyridine. The solvent is stored in enclosed reservoirs, built outside the works, in order to diminish the dangers of fire. If they are high enough the pyridine enters by gravity, otherwise it is forced in by compressed air. The cover is then placed on the boiler and the contents are heated to 100° C. This temperature is kept up for two hours, the agitator being kept going all the time. Steam is then shut off, and under continual stirring, the contents are cooled by running cold water through the jacket. The contents of the boiler are then run into an enclosed filter, in which the crystallized anthracene is separated from the pyridine mother liquor.

The anthracene remaining on the filter is treated again with 5,000 litres of freshly distilled pyridine in the same way. The pyridine running from the filter after this second treatment, which is relatively pure, serves for the first process. It is then recovered by distillation with superheated steam. A residue remains, which is run out while it is still liquid, and this solidifies on cooling. From 3,000 kilos of anthracene this residue amounts to 1,600 to 1,800 kilos.

The rectified anthracene still contains at least 25 to 30 per cent of pyridine, which is removed and recovered by a special process. The pyridine vapors are absorbed by sulfuric acid in a scrubbing tower, and when the acid is sufficiently saturated the pyridine is separated out with soda.

Crude acetone is also used, according to Bayer's patent. The choice of solvent depends largely on its price, and also on the greater or less facility of recovery. As relatively large quantities of the products have to be treated to obtain a rather low yield, the loss of solvent is necessarily high. It is estimated at about 10 per cent.

Instead of treating with a solvent to eliminate the impurities of the anthracene, chemical reactions can be used to separate the carbazole in the form of its potassium derivatives. A number of patents have been taken out to this end. This particular process has become important, as not only the anthracene, but the carbazole is recovered, and this latter product has become important for the synthesis of various vat colors.

The anthracene is finally brought to as finely divided a state as possible by sublimation with superheated steam. If this operation is well conducted the loss should not be more than 2 or 3 per cent.

Anthracene in the pure state forms white fluorescent scales. It melts at 213° C. and distils at 360°. It is but slightly soluble in the majority of solvents. It forms a picrate obtained as red crystals, fusible at 138° C.

It is interesting to note that absolutely pure anthracene is solely a laboratory product, whereas benzene and naphthalene are put on the market in a remarkably pure state.

Some Sources of Benzene and Toluene for High Explosives.

By T. F. E. Rhead.

[The following paper was read at the annual meeting of the Society of Chemical Industry, held July 18, at Birmingham. There is much of interest in it for American readers, as prospectively the demand for the two hydrocarbons in question may be notably increased in our own country during the coming months.—Ed.]

The preparation of synthetic phenol, and its subsequent nitration to picric acid, which has been successfully worked out on a commercial scale during the war, caused the great demand for benzene as the starting point of this process. The phenol used previously was obtained from coal tar, but synthetic phenol, being much purer, is far more satisfactory.

The trinitro derivative of toluene, T.N.T., was little known in this country three years ago, but the comparative safety with which it can be manufactured and handled, and its excellent explosive properties, caused an urgent demand for it, and consequently for the toluene from which to make it. The history of the Allies' success in producing this German explosive will, when written, be one of the most interesting romances of chemical industry.

The value of benzene and toluene for producing high explosives depends on their purity. Benzene is fairly easy to purify because it freezes at 4° C., but such is not the case with toluene, which freezes only when cooled to —90° C. Particularly troublesome impurities in some brands of toluene are those paraffin hydrocarbons which are neither removed by sulphuric acid washing nor by fractional distillation; such impurities complicate the nitration process and make it more expensive. However, when the supply of toluene was unequal to the demand, both the pure and paraffinic varieties were used for making T.N.T.; but since the sources of the pure substance have themselves become sufficiently developed, the paraffinic product, and likewise the processes producing it, have apparently been less profitable.

The various sources of benzene and its homologue toluene can be classified as follows:

(1) Synthetic, catalytic, and electrical processes.

(2) Certain crude petroleums containing them in the uncombined state.

(3) The destructive distillation of coal.

(4) The thermal decomposition or "cracking" of petroleum oils.

The methods under group (1) do not appear to have advanced much beyond the experimental stage.

When the urgent demand for toluene and then benzene had to be met, the Ministry of Munitions took the logical course of increasing the supply from the existing sources, and then of investigating and encouraging possible new sources.

The gas and tar from coke-oven recovery plants and a small proportion of gasworks tar supplied us with all the benzene and toluene we required prior to the war, and much was sent to Germany in part payment for the German recovery plants set up in this country. A large and little-known field of supply was town's gas, which often contains 30 to 40 times the amount found in the tar.

In the years immediately preceding the war the high price of petrol had focussed attention on benzol as a possible substitute, and several people had advocated washing this body out of town's gas.

Doherty, an American engineer, had urged the possibility in this country of recovering 2½ gallons per ton of coal carbonized for gas manufacture. However, the antiquated illuminating power standard prevented this procedure. The war demand put a new aspect on the problem, and a large and increasing proportion of town's gas is now being washed for these valuable products.

It became a matter of much import to know which system of carbonization gave the best yield, and although it is impossible to lay one's hands on reliable comparative data, the order of importance is, roughly: Horizontals, inclined, coke-ovens, intermittent verticals, and continuous verticals.

One great difficulty in solving this and allied problems has been the lack of a rapid, simple, and reliable test for the benzol content of a gas, and there is still much room for improvement in this test. It was early discovered that the benzol content of gas from continuous verticals was poor and high in paraffin content, and consequently not profitable to wash.

Many experimenters, encouraged by the Ministry of Munitions, worked on processes which were intended to increase the benzol content of coal gas. Experiments were carried out at the Birmingham Gas Works by Mr. E. W. Smith on the effect of carbonizing along with the coal such substances as coal-tar pitch, Mond gas pitch, petroleum residue, and bitumen in horizontal gas retorts.

The coal-gas pitch—a high-temperature product—does not give much increase in benzene and toluene, being already severely cracked, but the other three do materially increase the benzene and toluene content.. However, as only a small percentage can be carbonized at a time, it is not profitable to work the process for benzene hydrocarbon production.

Rollason, Stevenson, and others have tried the effect of carbonizing the coal along with lime or limestone, and claim that the latter acts catalytically and increases the yield of benzene, but further data are required to substantiate this claim. Experiments have also been carried out in passing inert gases and steam through gas retorts during carbonizing, in the hope of increasing the benzene yield by preventing its being thermally destroyed after formation, but little information is to hand as to the value of this method.

The various low-temperature systems of carbonization, introduced by the Coalite Co.—using a temperature of 400°— —500° C.,—produce no benzene, etc., but in the new coalite process employing a temperature of 650° C., a yield of 1.5 to 2.0 gallons of benzol per ton of coal carbonized is claimed.

It has long been known that various oils, especially those in crude petroleums, when subjected to the right conditions of temperature and pressure, break down or polymerise and yield a certain proportion of benzene and its homologues, the amount of which varies with the composition of the oil.

The mode of formation of benzene, etc., during the cracking of petroleum oils is parallel to that of its formation from the cracking of the primary decomposition products of coal. These latter contain many compounds found in petroleums, such as naphthenes, paraffin hydrocarbons, olefines, etc., and since it is far easier to separate petroleums into simple groups of compounds than is the case with coal, a systematic study of the thermal decomposition products of petroleum oil fractions should throw much valuable light on the mechanism of coal carbonization.

In Russia it has long been the practice to crack petroleum oils to obtain benzene and other aromatics for the dye and explosive industries and the shortage of coalfields made such an industry of vital economic importance. Moreover, Russian petroleums, being rich in naphthenes, lend themselves admirably to benzene formation. There is little doubt that this industry, founded by the Russian chemists, led by Nikiforoff, has received a great impetus from the needs of the war.

The first systematic work in the modern era, on producing aromatic hydrocarbons from petroleum, was carried out by Rittman, but the large-scale installation put down at Pittsburgh as a result of his experiments has been unable to compete with other sources of benzene and toluene owing to the small yield and poor quality of the products.

American chemists are working out the mechanism of oil cracking in a very careful manner, and much valuable work has already been done on the effect of temperature, time, contact, pressure, nature of the original oil, etc., by Rittman, Egloff, Moore, Twomney, and others.

The manufacture of carburetted water gas is essentially an oil-cracking process, and the evidence so far available goes to show that a good quality of benzene and toluene can be obtained by washing the gas from this process. In the early days of the war this source was unjustly ignored, owing to the lack of a good test for the benzol contents of a gas. The shortage of gas oil supplies has considerably handicapped this source in England, but it affords vast possibilities in America, the home of carburetted water-gas plants.

Some tests made at the Birmingham Gas Works showed that, of the oil cracked in this process, 3.27 per cent. appeared as benzene and about 2 per cent. as toluene, and the products were not seriously contaminated with paraffin hydrocarbons.

Egloff, experimenting with a Lowe carburetted water gas plant, obtained per 1,000 cu. ft. of gas, 0.07 gal. of benzene, 0.06 gal. of toluene, and 0.01 gal. of xylene. On this basis he estimates that the carburetted water gas manufactured in America, if washed, would yield annually 8,689,000 gal. of benzene, 7,448,000 gal. of toluene, and 1,241,300 gal. of xylene.

The Recovery of Toluene from Illuminating Gas.

The question of increasing the national supply of toluene by recovering the relatively small amount present in the illuminating gas of our cities is under active discussion. At a special meeting of the American Gas Institute, held in New York City in June, Mr. W. H. Gartley presented the essential factors of the problem very fully, as follows:

It has developed in the last few weeks that there are demands for trinitrotoluol for which no substitute can be accepted. Picrates made from the benzols are recognized for certain grades and kinds of high explosive work, and in one form or another will be used to a very large extent, but the urgent demand at the present day would appear to be for trinitrotoluol.

Increase Must Come from Gas Companies.

If there is to be any increase in the amount of trinitrotoluol made it must come from the toluol produced by the gas companies. All of the steel companies, with but one or two exceptions, that are now operating coke-oven plants have in operation light oil recovery plants in connection therewith and are producing therefrom pure toluol so that there is no use in looking to the steel companies or to the coke oven plants for any large additional amount of toluol in the immediate future. It is true that the coke-oven plants now under consideration and building will, within eight months to a year,—depending on the speed with which these coke-oven plants can be erected and put into operation,—increase the output of toluol to some 14,000,000 gal. per year, but at the present time any increase above the 10,000,000 or 11,000,000 gal. must come from the gas manufactured from gas companies, with possibly some small additional amount that can be had from natural gas by certain chemical processes. I would say, without betraying any confidence, that there is every prospect that there will be needed additional amounts of toluol. The Government officials have not said this; but we believe that beyond any reasonable doubt there is going to come to the gas companies a sudden and loud call for the recovery of toluol surely, and probably the toluol and benzol from their gas, and it is not unlikely that every gas company in cities of 75,000 inhabitants and over will have to give this matter immediate attention.

Therefore, from the standpoint of the Government officials, the information of our committee is that the need of the military branches for the by-products of the gas works has not yet dawned sufficiently upon the minds of those men of the Government who are able to commit the Government to any line of action, to force them, in the tremendous press of other matters, to act on this one. Apparently the Munitions Board at this time is not yet sufficiently conversant with the needs of our Army and Navy and those of our Allies to see clearly the way out of the difficulty as to the method of getting more of these by-products.

Now as to the gas companies' position. The gas companies are, of course, waiting for some word from the Goverment before they can go ahead to begin to put in these recovery plants. Is it true that the Government wants more toluol and benzol? Are the other materials that are needed to be used with toluol in the manufacture of trinitrotoluol available in sufficient quantities for the manufacturers to use a large extra amount of toluol?

Installation of Plant an Important Item of Expense.

The installation of such recovery plants is going to be a very important item of expense, especially at this time when we believe we are on the crest of a wave of high prices for labor and material and the almost insuperable difficulties in the way of getting materials.

Again, there are some of the largest companies where the most toluol can be obtained per dollar invested or in a given time, that are prevented from going into the business on account of the candle power standards set by the public service commissions or by contract. It will be necessary, before such companies can start on this to have these high candle power standards withdrawn, and that these companies be allowed to take out the toluol and benzol and leave a good satisfactory gas for the consumers.

Effect of Recovery on Gas.

What effect will the recovery of toluol and benzol from the gas have upon the gas sent out to the consumers? Personally, it seems to me very clear that the questions of a large reduction in heat units, and the recovery of toluol from the gas, are very distinct. If it is desirable to get all the toluol that is practically possible from our gas, the maximum quantity can be obtained if the gas companies will use in the manufacture of water gas as much oil as they are using at the present time, since the production of toluol is a function of the amount of oil used. I am referring now to those works making a high candle power gas. It would not be necessary or desirable for those gas companies, if they were relieved of their candle power requirements and put on a heat unit basis as many of the other gas works are, to reduce the quantity of oil used so as to get down to the lower standard of heat units; that is, speaking as I am from the point of toluol recovery. In those companies that are now working to, say, 550 to 570 heat units, it might be possible, although at extra cost, to make up by the use of additional oil for the loss in heat units due to the benzol oils recovered and not put back, when they get started on toluol recovery.

The gas companies now find themselves in rather serious straits, and the question of an increase in their rates is one that must engage the attention of the authorities in a very short time. The increasing costs of labor and material have very much increased the cost of gas, and the companies generally may justly claim the right to increase their charges.

Relation to Rate Changes.

But the question of the recovery of toluol and the loss in the heat units and candle power caused thereby might be considered, under ordinary times, as a feature of the whole question of change in rates, but at the present time it should not be so considered, and in saying this I know that I am to some extent antagonizing the representatives of the Bureau of Standards with whom I have talked.

These representatives have said to me that if the toluol, or both the toluol and the benzol are recovered from the gas, either wholly or in part, there will be a reduction in the heat units and also a reduction in the candle power, and the consumer will get less for his money than he did before, and consequently this is an argument in favor of a reduction in rates to the consumer under these conditions.

My reply to this has been that the emergency will not permit of mixing this question with that of change of rates for those companies that are now making a high candle power gas; that the reduction of heat units, due to the recovery of toluol, would not be sufficient to lower the gas below a first-class heating value; that where this gas is made up of mixed coal and water gas, or water gas alone, it would still be possible in New York, Chicago, Brooklyn and Philadelphia to recover the toluol and leave a gas of as good heating value as is distributed to the consumers of the other gas companies in those states; and that the burning of the toluol and benzol now being sent out by those companies, which are obliged to use a large quantity of oil per thousand feet, is almost a crime in view of the pressing necessities, for high explosives, of our young men who are now going out to fight our battles. I believe that it will be necessary for the proper Government officials to take up with those authorities having jurisdiction over the larger gas companies now making high candle power gas, the question of at once relieving them of this necessity.

This of course must be done by careful consideration of the conditions surrounding each individual company and it will require in this capacity a representative of the Government who has intimate and particular knowledge of the gas companies' conditions, of the relations of the gas companies to the consumers, and in a general way all of the many questions that have hedged the gas companies in regards to their regulations and legal conditions.

Cost of Equipment Question to be Settled.

Now, outside of these large companies with high candle power requirements, there is nothing particular, as a rule, to prevent the gas companies at once starting in to recover their toluol upon notice from the Government to go ahead, except the question of cost of equipment and how the gas companies are to be reimbursed and provide for amortization of the plant in a very short time, say a year and a half to two years.

The cost of erection of these plants will because of the press of high prices at this time, be such that the companies will not get their money out of the plants within a year if toluol sells at $1.50 per gallon. The Government in this case should be willing to provide the money for the erection of these plants, or they should guarantee to the gas companies such a price for their toluol over such a period of time as will surely provide, with economic and careful work in the matter of toluol recovery, for amortization of the plant and those incidental expenses, such as reduction in volume, etc., that are contemporaneous with toluol recovery.

I hope that there will be a discussion here today of what is in the minds of the managers of gas companies regarding this question of toluol recovery. This will be useful in guiding the committee in its work. This committee has had several meetings and a number of things have been developed and a great deal of progress has been made in clearing up the situation for quick action. We have shown the Government that it must come to the gas companies for any excess toluol until the time when the steel companies can get ready to increase their production; that the gas companies can not act until the Government tells them to, and we are prepared to discuss, upon invitation, the procedure to be adopted in order to get this additional toluol. A survey of the quantities of toluol that will be required for ourselves and our Allies has been made in Washington and the facts obtained from that survey make us believe that the Government will have to strain every effort to get all the toluol that can be obtained, at least from the larger companies.

Replying to a question as to whether the committee had come to any definite conclusion as to the smallest plant it thinks could be operated in the production of toluol, Mr. Gartley explained further:

That is a question which can be determined very largely by the amount of toluol the Government will need. Of course, there is also the question of the building of the plant to do the nitration and the securing of the nitric acid and the sulphuric acid. At the present time the Government is seriously in need of more toluol than is at present produced, and that production is now about 10,000,000 gal. yearly.

There would be provided by all companies in cities of over 75,000 inhabitants, eliminating those now taking out toluol and those with natural gas, something like 3,500,000 gal. additional. Whether this is sufficient to give the Government all that is needed has not yet been officially stated, and it probably never will be stated because it is based on certain conditions and the evidence is very strong that there will be a still greater demand than is now figured on as being necessary to prepare for immediately. It is quite conceivable that the gas companies in cities of as low as 40,000 inhabitants may be called upon to recover their light oils, and the collection may still be made more general.

If you have 570 heat unit gas, you will not get as much toluol per thousand feet of gas as those companies manufacturing a high candle power because you will not use as much oil. Assuming a recovery of 0.05 of a gallon of pure toluol per thousand feet of gas—and it may be that this is a little high for the average—I have said that towns of 75,000 inhabitants will recover 3,500,000 gal. of pure toluol. The Government is not now, I think, figuring ahead more than six months, and you can readily see that there is so much to be done at once that six months ahead is a long way from now, and the main question now is to get toluol from the gas companies and be reinforced later by the additional quantity that will come from the steel companies.

Mr. Ramsburg thinks that 3,000,000 gal. will be produced by the new steel plant being erected. The future of the toluol business, after the war, of course is not at all encouraging. The only use that you can have for it that is known now is its substitution for gasoline as a motor fuel, and in dyes and a few medicines.

In 1913 there were only 750,000 gal. of toluol produced in the country, so when you come to making 17,000,000 gal. and knowing what to do with it after the war is over, I think the steel companies can have that business if they want it.

The benzol production is liable to be embarrassing. In order to get out this toluol so much benzol is also taken out that the market is filled with benzol, so that the price can not stay up.

There has been an enormous increase in the coke-oven business in Germany. They have succeeded in getting nitrogen out of the air to make their nitric acid, and are using and have used trinitrotoluol right straight along. In England and in France very small works are undertaking the recovery of toluol. They were in terrific haste to get something. You will remember how, under the pressure of their demands, the prices of toluol increased about twenty-five times its former value in this country, and their idea was to get it out of all the small works. But they made one mistake.

Mr. W. H. Fulweiler, upon request, furnished the following explanation regarding methods of recovery in England:

In the mad haste the English people had to fortify with high explosives, they adopted what is known as a "C" process, which was the suggestion of Charles Carpenter. He said any old works can rig up a tar scrubber, and that was the most available means to get the tar out of their gas. They simply brought the coal tar into contact with the gas and extracted some 60 per cent. of the toluol, and the tar was sold to the tar distillers. But even with the introduction of the mineral apparatus, there was the serious handicap that they were handling a five-rail fence in order to catch a sparrow. The amount of toluol secured was very small.

Furthermore, the tar distillers over there, according to the gas literature, did not supply it on any arrangement like fifty-fifty, on the increased production of toluol. Furthermore, it was difficult to arrive at any correct referee method of determining how much they had enriched their gas. So it did not turn out to be a satisfactory process. All of the larger plants then began to turn almost immediately to oil instead of tar. They used practically the same scrubbing apparatus, and then they steamed their oils, and this increased the efficiency of their extraction. From that they have developed into flowing live steam into this oil with which the gas has been scrubbed, and they can in that way get a higher oil extraction and recover all light oils.

Mr. Gartley amplified Mr. Fulweiler's explanation by the following statement: I think the method we should use is to wash the light oil out of the gas by the use of a wash oil, and select as a wash oil one from which the light oil can be readily separated. The process is to wash the light oil out of the gas; then separate the light oil from the wash oil; then distill the separated light oil so as to get one fraction particularly rich in benzol, another rich in toluol, and leave the residue in the still, unless you want to go one step further and separate also the light naphthas.

The next step, then, would be the refining of these crude benzols and crude toluols into pure products. This can be done at the gas works but it is not an essential part of the gas works' plant, since these crude benzols and crude toluols can be shipped to other places for refining, provided transportation facilities are available. We must keep in mind the great scarcity of tank cars, barges and steel drums and the high prices for those commodities if new ones are purchased.

If there is no demand for your benzol, of course it must be immediately put back in your gas, leaving only the toluol fraction to be treated. You will not be able, probably, to figure on taking all of the toluol, benzol and solvent naphtha out of the gas; with some water gas if you did, it would bring the candle power down to three or five candles, and of course this is too low to send out. So you will have to be satisfied in taking out the material which when distilled and washed with acid will net 0.04 to 0.05 of a gallon of pure toluol per thousand feet of gas, depending on the quantity of oil used in making the gas. The amount of light oil recovered from the gas will be determined by the amount of wash oil that each thousand feet is exposed to in the wash oil scrubber. It will be possible to take out 0.04 to 0.05 of a gallon of C. P. toluol with the use of six gallons of wash oil for each thousand feet of gas.

To get all of it you might have to use 20 gal., and this of course would mean a large increase in the size of stills necessary to handle this large quantity of wash oil. Therefore, it is advisable to get a wash oil that is avid for the light oils in the gas and which will readily give up this light oil again under proper heat treatment in stills, since by this method you can reduce the size of the plant needed. It is very unsafe to make any attempt, based on experience of three or four years ago, to prophesy what it will cost to put up an apparatus that will simply recover the light oil from the wash oil, and divide the light oil so separated into crude benzol, toluol and naphtha fractions. In a city of 75,000 inhabitants it would appear that it would be unsafe to say that the cost of a plant for the recovery of toluol could be covered for less than $2.00 per gallon of C. P. toluol for a period of two years.

It is desirable that the selection of the apparatus to be used for toluol recovery be as cheap as possible, yet it should have the main consideration of reclaiming as much toluol as possible from the gas consistent with leaving a good serviceable gas for the consumer, and producing the toluol in such a way as to be available at once for the manufacture of munitions.

Equipment Needed.

It does not require much special apparatus. The main thing is to get hold of some steel. I know that this is not easy to get new, but I have in mind taking some steel containers that you may be able to pick out from your older material around your works, and if you have nothing of that kind that can be taken down you want to think a long while before you think of getting sheet steel on any new orders that you will now put in. Perhaps there may be some relief in this direction when the Government finds the absolute necessity of getting this toluol out. The other necessities are a few castings which you should be able to get because they are not large, and if you can get these castings and the necessary sheet steel. not much more is required, and you might poke around your works for the balance. Of course, if you want to build a handsome plant for show, it will take you sometime to get it and the war will probably be over when you are ready to produce toluol.

The German Coal-tar and Explosive Industries.

An understanding has been arrived at between the works of the big chemical industry, the so-called "aniline" concerns, and the "explosive group," and indirectly also with the "powder group," which latter works in connection with the explosives group. The new arrangement may be looked upon as settled, even if all the documents have not yet been actually signed. The aniline works, from the stoppage of their export trade and the dearth of raw materials, have been compelled to curtail their regular peace manufacture, and instead go in for the production of materials used in the explosives industry and of actual explosives. It is this increased production of explosives, etc., which has enabled Germany to carry on the war as she has, and has even resulted in a surplus, and this, again, is due more especially to the vast increase in the atmospheric nitrogen industry. As long as the war, with its immense munition requirements, goes on, this increased production will not be attended by any drawbacks. The new arrangement is only intended to come into operation after the war. Its purpose is to secure and fix the production of the respective groups, which at present is very much alike, and to lay down mutual limitations of the manufacture. The individual groups will maintain their complete independence and entire freedom within the allotted domain, and will consequently also have free hands altogether as regards their price policy.—*Engineering.*

Estimation of Benzol in Gas.

According to the *Gas World,* Neubeck's method of freezing out the benzol of illuminating gas, for the purpose of analytical estimation, gives good results in the laboratory of the Zürich gas works. Solid carbon dioxide is used and a uniform temperature of 79° C. is maintained. The condensate is free from oily matter but its very low specific gravity, 0.852 at 17° C., indicates the presence of lighter components recovered, also, from the gas.

Coal-Tar Crudes in Australia.

Little effort has been made hitherto to secure benzene and toluene from the coal-tar of Australian gas works. Under the stimulus of the present heavy demand for the two hydrocarbons in the manufacture of munitions, the Defense Department of the Australian Government has decided to erect the necessary plant for refining crude benzol, and to secure all available supplies of the latter from the gas companies of the commonwealth.

The British Supply of Coal-Tar.

Early in the year, the British Controller of Coal Mines appealed to the gas industry to economize as far as possible in the consumption of coal, in the interest of all fuel users, urging the substitution of water gas wherever practicable. This policy is now reversed, as the Minister of Munitions finds it necessary to secure the maximum output of coal-tar by products. The most recent instructions are to utilize the distillation plants of all gas works to the fullest extent before manufacturing water gas, carburetted or uncarburetted. The effort is made to recover as much of benzene, toluene and phenol as possible.

COAL-TAR INTERMEDIATES

Sulfonating Kettles.

The sulfonic acids, in almost bewildering variety, play such a dominant rôle in the manufacture of synthetic colors, that all pertaining to improvements in the processes of their industrial production possesses a constantly increasing economic value.

In *Metallurgical and Chemical Engineering* for August 15, 1917, Mr. Frederick Pope, who has devoted much attention to the technique of this branch, contributes a valuable study, profusely illustrated, on the fundamental factor of the manufacture, the kettle or "sulfonator." From the exhaustive study we quote the following:

Sulfonating kettles are made of cast metal, for instance, cast iron or various acid resisting metals such as Duriron, Tantiron, Corrosiron, Buflokast, etc., the ratio of depth to diameter and shape of bottom varying widely according to the service required of the kettle. They are ordinarily discharged either through the bottom or through a permanent or temporary tube inserted through the top, in which case air pressure is used to empty the kettle.

A frequently used type of sulfonating kettle is made of cast iron. The jacket may be either cast iron, or more often, boiler plate. Such a kettle is useful for such sulfonations as require either no external supply of heat, or a supply of heat at a low temperature.

Usually the source of heat is low pressure steam in the jacket, the steam being admitted through openings around the top of the jacket, and the condensation drawn off through an opening at the bottom.

This type of jacket is used when the source of heat is hot water, or when cooling water is used to control the temperature within the kettle.

When the kettle is heated by low pressure steam, a space of 1 to 2 in. between the outside of the kettle and the inside of the jacket is sufficient. but when hot water is used for heating or cold water for cooling, the space should be at least 4 in. These figures are for medium sized kettles, 4 to 5 ft. in diameter. When either hot or cold water is used, care must be taken that it is introduced at a number of points, and drawn from a number of points to prevent hot or cold streaks in the jacket.

Steam jackets of this sort carefully designed and well built may be used for temperatures up to 130° C. The jacket should be carefully insulated with asbestos or other non-conducting covering.

An example of a kettle of this sort is the one used in the sulfonation of benzol to benzol-sulfonic acid, which is heated to a point between 80° and 110° C., depending upon the method used, and is equipped so that water may be admitted into the jacket for cooling in case of overheating.

When a higher temperature than 110° C is desired, we face a more difficult problem. If we use steam as the source of heat, higher pressures are necessary, and we have the awkward problem of cylinders of large diameter subject to collapsing pressure from the outside.

A number of methods have been devised for solving this problem. Superheated water is successfully used abroad in place of high-pressure steam. In constructing a kettle for high pressure steam, coils of wrought iron pipe are placed in the mold for the kettle, and cast iron is poured around them. It is reported that this construction is successful abroad. According to available data it has never been very successful in this country, the difficulty being the difference of coefficients of expansion between wrought iron and cast iron. It presents a very attractive method of heating if it can be worked out.

In another method of construction for high pressure steam, the jacket and inner shell are made of boiler plate, into which a lining of cast iron is poured.

Another method of getting high temperatures is to use superheated steam, the steam being at a low pressure. The objection to this method is the fact that one encounters innumerable well-known mechanical difficulties. The chief objection to superheated steam, besides these mechanical difficulties, is the fact that the more highly steam is superheated, the nearer it approaches a gas, and the less becomes its weight per cubic foot. Both of these lessen its value as a medium of carrying heat.

A perfectly obvious way of obtaining high temperatures in sulfonating kettles is to discard entirely the jacket and to heat the kettle directly, using preferably gas or oil for fuel, or to heat the kettle in a current of hot gas coming through a checkerwork, the checkerwork tending to give even temperatures.

Another way is to surround the kettle with a steel jacket, forming an air bath. This method has been successfully used, but the thermal efficiency is not high.

The last method for heating a kettle to a high temperature is by the use of some circulating medium, for instance, oil. In such a case we use a kettle similar to that adapted for hot water heating, the oil entering a number of places in the bottom, and leaving through a number of openings spaced around the top. Such a system requires, in addition to the kettle, a heating coil, a circulating pump, an expansion tank, and a reflux condenser. The expansion tank should be equipped with a steam-heating coil to heat the oil before circulation is attempted. The first time the oil is used, the temperature should be raised gradually, as even the best circulating oil contains some water, which must be driven off before this system will work smoothly.

Temperatures up to 150° C. may be maintained with the mineral oils available without serious deterioration of the oil. If it is desired to maintain a higher temperature, the oil-circulating system should be provided with a reflux condenser to return to circulation anything that might be driven off. When the system is equipped with reflux condenser, temperatures up to 300° may be maintained.

A standard form of superheater re-arranged so that all the pipes are in series instead of some of them in parallel makes an excellent oil heater. The heater is preferably fired with oil or gas on account of the ease in regulation. This system should be equipped with a recording thermometer. In a well-designed oil-heating system, it is possible even when running a number of kettles from one heater to maintain the temperature within one or two degrees.

A sulfonating kettle is ordinarily equipped with a thermometer tube extending well into the liquid. It is always desirable to use a recording thermometer in connection with a kettle.

A sulfonating kettle must always be provided with a cover to prevent loss of acid through evaporation or the weakening of the acid by abstracting water from the air. The cover may be of cast iron or boiler plate. The joint between the kettle and the cover is usually made either of lead or asbestos, although in some cases the cover is simply bolted to the kettle. The cover should have the following openings: A manhole as large as possible up to 14 in. by 15 in. diameter; an opening to admit sulfuric acid; in some cases a pipe connection to admit liquids, as for instance in a phenol plant, benzol, while in other cases, in making b-naphthol for example, the material to be sulfonated is charged through the manhole. In some instances, it is desirable to have an opening for a pressure gauge or other form of manometer. If the kettle has not a bottom discharge, there is either an opening for inserting a temporary tube to the bottom or a permanent tube extending to the bottom, and an opening for compressed air for discharging the charge. It has been proposed to discharge the kettle through a hollow agitator shaft, but this is not recommended. There may be necessary an opening for the escape of fumes or for a condenser.

In the case of many reactions, often in the sulfonation of amino compounds, the reaction mass must be cooled in order to limit sulfonation. This cooling may be accomplished by either introducing water into the jacket if possible, or by having closed-end pipes of enameled or acid resisting iron extending into the mass, and running cooling water or brine through these pipes.

The apparatus must be designed to meet the requirements of the reagent used. Ordinary pig iron, which is generally employed, can not be used with fuming acid, since it is quickly corroded by the high temperatures, which are often maintained for hours, in such a way that gas accumulates in the pores of the iron (hydrogen, carbon dioxide, etc.) which may cause disintegration. Wrought iron is strongly corroded by fuming acid containing up to 25 per cent SO_3, at which strength it is again passive.

Various linings may be used. Enamel or lead applied directly to the inside of the kettle, or a chemise of nickel are used. The advantage of a nickel chemise is that when it is used up, it may be withdrawn and replaced by a new one.

Kettles have been built with horizontal stirring devices, but this is not desirable because of the difficulty in keeping the stuffing boxes tight when the shaft is in a bearing in contact with acids. It is also true that a horizontal stirring apparatus requires more power than a vertical one. A slanting stirring device gives uniformly good results, but for some undetermined reason is seldom used. The writer recommends it to the earnest consideration of users of sulfonating kettles.

Nearly all sulfonating kettles are provided with agitators of which there are a number of forms in use. The ordinary "U" type of agitator with the center line of the shaft coinciding with the center line of the kettle is a common type, and for many uses very successful. This type of agitator is also used with the center line of the shaft parallel to the center line of the kettle, but a little off center, which gives a better agitation.

Another type of agitator which is very useful for certain purposes consists of a number of "U" type agitators with breakers.

The propeller is largely used as an agitator in a number of different ways, and although it is undoubtedly the ideal agitator under certain conditions, it cannot be used indiscriminately. There is one correct speed for the propeller type of agitator, which depends upon the size and shape of the kettle, the size, form and pitch of the propeller, and the liquid in the kettle. A comparatively small variation from this speed will reduce greatly the efficiency of the agitating device. It follows that the propeller type is usually unsuitable in a sulfonating kettle in which the character of the liquid changes in the course of the reaction.

A single propeller is often used. A modification of this, considered by some to be an improvement, is to inclose the propeller in a tunnel.

Another arrangement favored by many is two propellers on the same shaft, one propeller throwing in one direction, and the other in the other. Often these propellers have varying pitches. An arrangement of this sort well thought of in England has two propellers working in different directions with different pitches, with side breakers on the inside of the kettle, the shaft carrying the propellers revolving rapidly (250 r.p.m.). In certain work, it is reported to have been very successful.

In the opinion of the writer the best arrangement of the propeller is either one or two propellers; in case two are used, with varying pitches, and throwing in opposite directions, the shaft carrying the propeller or propellers parallel with the center line of the kettle, but a certain distance off center.

There are a number of special types of agitators for particular service used in sulfonating kettles. For instance, there are kettles built in which the shaft carrying one agitator is hollow, another shaft extending through the hole in the shaft carries another agitator revolving in the opposite direction. There are scraper types of agitators for particular purposes. In fact, the desirable type of agitator must be chosen in each case, and can only be determined by experience and study.

In a bottom discharge kettle, the design of the bottom discharge must be carefully considered. Many makers design a sulfonating kettle in which the discharge pipe passes through a stuffing box in the outer jacket and is screwed into the sulfonating kettle. For some uses, this construction is applicable, but often the screw threads are attacked by the acid, the threads in the casting being attacked as well as the threads in the discharge pipe. When the threads in the kettle have been destroyed, troublesome repairs are necessary. It is much better to introduce a spool piece between the kettle and the jacket. The valve controlling the discharge can be bolted directly to this spool piece.

Another method is to make the discharge pipe of cast iron with a flange cast on either end. The discharge pipe is bolted to the sulfonating kettle, passing through a stuffing box in the jacket. In this case it is necessary that the stuffing box and gland be split.

There has been considerable interest of late in continuous sulfonation, a number of schemes having been devised for the purpose. A step in this direction is sulfonation in two stages, which has been very successful in at least one large works.

Explosions of Picric Acid.*

By T. Sington.

The process of making picric acid consists broadly in mixing carbolic acid with strong sulphuric acid, diluting this sulphonate with water and then running it slowly into nitric acid. The mixture is allowed to cool, when the crude picric acid crystallizes out and it is subsequently purified by re-crystallization. After thorough washing with water to remove all traces of free nitric and sulphuric acids, the material is whirled in a centrifuge to remove the bulk of the water. It is then removed to the drying shed where it is spread on glass steam-heated beds until all moisture is removed. The acid is then transferred in large open drums to the sifting room where it is ground, passed through a revolving screen, taken to the packing room, and packed in barrels of 100 pounds each. The large crystals which fail to pass through the sieve are reground in a crushing mill.

A suitable range of buildings for the manufacture of picric acid may consist of five buildings in which the wet processes of manufacture are carried out, and of four or more others in which the acid is dried, sifted, packed, and stored. These buildings ought to be separated from one another and from the "making" rooms by intervals of about 30 feet.

Explosions in picric acid factories are of rare occurence, but the destruction is then so thorough that there is considerable difficulty in tracing the cause. In opinions based on prolonged experience and on records extending over a long period of time, it has been considered that an explosion is impossible, provided the quantity of acid in any one building is limited to a moderate amount and that the acid is absolutely free from picrates. An entire factory may thus be regarded as constituting a fire risk rather than an explosion risk, and consequently no distances beyond those necessary to prevent the communication of fire are necessary. Brick walls have therefore been deemed sufficient to protect life, inasmuch as explosions of picric acid have always been preceded by a fire of some minutes' duration.

In the case of an explosion of picric acid two separate and distinct questions may present themselves for discussion: First, the means by which the heat necessary for ignition is produced, and, secondly, why an ignition may develop into an explosion, instead of merely resulting in a comparatively harmless combustion. One of the manufacturing processes through which the material passes is of a nature which in connection with explosives is never entirely free from risk—this is the operation of grinding the larger crystals of picric acid which have failed to pass through the screen. While picric acid is by no means easy to ignite, when it occurs ignition is most likely in the grinding mill. Thus, the operation of grinding *dry* acid occasionally gives rise to fires, which may not be followed by explosions and which are readily put out, but the possibility of explosion is always present.

That the mere process of grinding is not necessarily dangerous follows from the immunity experienced during the operation of drilling out the primer space in the solidified charge of filled shells by means of power-driven steel drills, a method which has been very generally employed without the slightest accident. It does not necessarily follow that because picric acid may be safely ground in an iron mill, that nails, stones and similar hard foreign bodies which may accidentally find their way into the powdered material, are equally harmless. In fact, many fires in picric acid factories have been traced, after careful examination, to the presence of a nail in a grinding machine. Foreign bodies may find their way into the hoppers of grinding machines in a variety of ways, but it is contrary to all experience that an explosion should follow ignition. Should this occur, it would be necessary to reconsider all previous conclusions, and even to modify to a very considerable extent the conditions of manufacture.

A picric acid explosion of exceptional violence, causing widespread destruction of property, occurred in one of the manufacturing towns of Great Britain many years ago. After an exhaustive inquiry it was established beyond all possibility of doubt that the explosion was due not to picric acid alone, but to the presence of considerable quantities of lead and strontium compounds, which under the influence of heat and in contract with the melted picric acid led to the formation of lead and strontium picrates, both of which, and more particularly the lead salt, are not only in themselves violently explosive, but are capable of detonating picric acid in contact with them. Another explosion of picric acid occurred after a fire had been raging for nearly ten minutes; it was said to have been due to the formation of picrate of lime from the mortar in the roof of one of the buildings.

Textbooks for many years stated, on the authority of chemists of the highest standing, that when suddenly heated, picric acid will explode, but the actual experience of manufacturers furnishes a very emphatic contradition to this statement, that pure picric acid when unconfined cannot be exploded by fire. Investigation of accidents such as the above also support this view, as do also the results of experiments instituted for the special purpose of clearing up this point. A case is recorded in which an iron vessel with a very small orifice and containing 25 lbs. of picric acid was placed in a reverberatory furnace, when the acid burned away without explosion.

It has been found quite possible to explode picric acid by a blow, but the blow must be one of considerable force, if the material is cold. In fact, all experience appears to prove, as surely as negative evidence can be said to prove anything, that it may be taken as a practical impossibility for picric acid to explode without giving sufficient warning by fire to enable anyone in the vicinity to escape, and moreover a fire in its initial stages can be extinguished by water without much difficulty.

---

* From *Metallurgical and Chemical Engineering, August 1, 1917.*

In the best planned picric acid factories the quantity of material which may be present in any one compartment is limited to 2000 pounds. When this limit is adhered to, and suitable sprinklers fitted up in every building liable to contain picric acid, the danger of a fire developing into an explosion is so slight as to be negligible. The process of dry grinding is also being discontinued, and some method of dealing with large crystals in a wet state substituted.

Manchester, England.

Conflagrations in Coal-Tar Chemical Plants.

During the past few months there have been so many fires in works devoted to the manufacture of coal-tar intermediates and colors, that the inherent causes have been a matter of much discussion. A recent issue of *The Journal of Commerce* contains the following extremely sensible review of the situation by Mr. E. O. Torbohm, a well-known insurance inspector:

"There is danger that several recent fires in plants engaged in the manufacture of intermediates for aniline dyes will lead underwriters to the mistaken conclusion that all chemical processes are alike dangerous. Analysis will show that most, if not all, of these fires are due in greater or less measure to war conditions, i.e., undue congestion or inadequate facilities, coupled with insufficiency of skilled help and a feverish desire for quantity of output rather than for quality. It may be further noted that only a certain class or type of these risks have burned or distinguished themselves explosively.

"American emancipation from dependence upon the German dye industry is now an old story. That our dependence in this respect was a purely economic one has been abundantly proven since the outbreak of the present world war. To the numerous eminently capable men efficiently qualified to lead in this emancipation have been added, however, a host of speculative jugglers, poorly equipped with the requisite ability, however well they may have succeeded in securing the necessary capital.

"Hastily renovated or reconstructed properties, illy adapted for the purpose, have been everywhere pressed into use, and machinery and equipment costing hundreds of thousands of dollars installed in mere shanties. When to these natural disadvantages are added the difficulty in securing uniformity in grade of raw material, and a sufficiency of capable workmen, the wonder is that so many low-grade plants remain intact.

"The built-for-the-purpose, efficiently equipped and adequately manned establishments are obviously not in the same category. Likewise the manufacture of staple crude and refined chemicals when rationally conducted should be free of any abnormal fire hazard. This is especially true of the manufacture of drugs and pharmaceutical chemicals. While the expected rewards have been equally as great, even greater, on certain items in this trade, the class or grade of men engaged in it seems to be of that high standard which makes for deliberation in action, as well as in thought. With few exceptions, there is as much difference between this class and the one responsible for the present chemical fire record as there is between a watchmaker and a boilermaker. Moral: Beware of the boilermaker."

Manufacture of Benzene-Sulfonic Acid.

A simplification in the manufacture of benzenesulfonic acid is proposed by the Compagnie des Produits Chimiques d'Alais et de la Camargues, Salindres France, (Br. Pat. 101,973 of 1916). Benzene vapor is passed through sulfuric acid, maintained at the favorable temperature. The excess of benzene, passing out from the sulfonator, carries along, in the form of steam, the water present in the acid and that liberated during sulfonation. This current of vapor is dehydrated before it is returned to the acid. It is claimed that the process allows the use of sulfuric acid of any degree of concentration, that all of the acid employed is effectively utilized, and that the resultant sulfonic acid is practically pure.

A New and Sensitive Indicator.

M. T. Bogert and G. Scatchard (J. A. C. S., 1916, 38, 1606) find that the monosodium salt of dinitrobenzoylene urea is a very sensitive indicator for hydrogen-ion concentrations between the limits of 6 and 8 on the Sörensen scale, changing from colorless to greenish yellow. It resembles p-nitrophenol most closely. This indicator is but slightly affected by neutral salts and proteins, not at all by chloroform, toluene or nitrous acid. It can be used in cold or boiling solutions, a sharp end point being obtained with ammonia and HCl. Its color fades very slightly in about a week, and it is not suited for titrating carbonates. It is believed to be superior to rosolic acid in preparing neutral ammonium citrate for fertilizer and soil analyses.

Dr. R. P. Rope, lately connected with the Mellon Institute at Pittsburgh and the General Coal Products Co., is now at St. Louis, engaged upon the construction of a phenol plant.

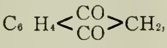
Dr. Allerton S. Cushman, president of the Institute of Industrial Research at Washington, is now a major in the Officers' Reserve Corps, and has been assigned special research work on the chemistry of high explosives, under the ordnance section.

ARTIFICIAL COLORS

A Series of New Ortho-Oxy-Azo Dyestuffs Containing Copper.

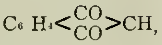
Dr. Berthold Wuth and Dr. Carl Jagerspacher, of Basel, Switzerland, assignors to the Society of Chemical Industry, of Basel, describe (Amer. Pat. 1,233,433, of July 17, 1917) an extensive new series of azo colors containing copper, derived from various ortho-oxy-azo dyestuffs prepared from polycyclic ring systems in which there is a CH_2 group susceptible of combination with a Siazo group.

Such polycyclic ring systems are:—
diketohydroinden,



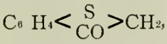
$$C_6\,H_4<\substack{CO\\CO}>CH_2,$$

peri-naphthindanion,



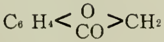
$$C_6\,H_4<\substack{CO\\CO}>CH,$$

3-oxy-1-thionaphthen,



$$C_6\,H_4<\substack{S\\CO}>CH_2,$$

ketocumaran,



$$C_6\,H_4<\substack{O\\CO}>CH_2 \quad \text{and}$$

indoxyl,

$$C_6\,H_4<\substack{NH\\CO}>CH_2$$

The above, as well as their derivatives, can be transformed into soluble copper compounds, by treatment with copper salts, copper oxide or copper hydroxide, similar to those obtained at an earlier date, by the inventors, from simpler ortho-oxy-azo dyes (Amer. Appl. for Pat. 43,413, of Aug. 3, 1915).

The copper compounds, soluble in water, thus obtained, from which the copper cannot be precipitated by sodium carbonate, soda lye and ammonia, yield in an acid bath on animal fibers and leather, further on straw and wood-bast, valuable red, brown, violet-blue to black tints of good fastness to washing and to light. They are distinguished from the ortho-oxy-azo dyestuffs, employed as parent materials, by entirely different shades and by a better fastness. The new copper compounds dissolve in concentrated sulfuric acid to deep colored solutions and in water to intense colored solutions which do not change their coloration on the addition of sodium carbonate or of soda lye.

The preparation of these dyestuffs from ortho-diazo-phenol derivatives or ortho-diazo-naphthol derivates and peri-inaphthindandion, ketocumaran, indoxyl, etc., takes place in the usual way by combining the ortho-oxy-diazo compounds with the various components in an alkaline solution, as is illustrated by the following example:

Example 1: 24 parts of 1:2:4-amino-naphthol-sulfonic acid are diazotized in the customary manner and mixed with a soda alkaline solution of 20 parts peri-naphthindandion, dissolved in 14 parts of soda lye of 30 per cent. The combination being achieved, the dyestuffs is separated, pressed and dried. It dissolves in water to brown-red, and in concentrated sulfuric acid to blue solutions, and dyes wool in an acid bath violet-brown shades.

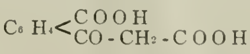
The preparation of the copper compounds of these ortho-oxy-azo dyestuffs is illustrated by the following examples:

Example 2: 24 parts of the dyestuff obtained, according to Example 1, from 1:2:4-diazo-naphthol-sulfonic acid and peri-naphthindandion, are dissolved in 1000 parts hot water at 80° C., and into the solution is poured a solution of 13 parts of copper sulfate in 50 parts water. The copper compound separates at once as a black precipitate. After neutralization of the freed sulfuric acid with sodium carbonate, the new copper compound is isolated by filtration, pressed and dried. It dyes wool in an acid bath brown-red shades, very fast to washing and to light.

Example 3: 21 parts of the dyestuff resulting from 1:2:4-diazo-naphthol-suffonic acid and oxythionaphthen, are dissolved in 700 parts water, and to this solution are added, at about 70° C., a solution of 13 parts copper sulfate in 50 parts water. The blue copper compound precipitates at once. After neutralization with sodium carbonate, the new copper compound is separated by filtration, pressed and dried. It yields on wool in an acid bath very pure violet-blue shades, fast to washing, alkali and light, while the ortho-oxy-azo dyestuff employed as parent material yields valueless rose-colored tints.

The tabular exhibit (*p. 260*) shows the variety of tints obtained from a few of the possible combinations employed with polycyclic compounds.

In a later patent (Amer. Pat. 1,234,994, of July 31, 1917) the same inventors describe a closely allied group of dyes, constituted by the copper compounds of the ortho-oxy-diazo dyestuffs derived from ortho-carboxylated benzoyl-acetic acid.



$$C_6\,H_4<\substack{COOH\\CO-CH_2-COOH}$$

The preparation of the heretofore unknown dyestuffs from ortho-diazo-phenol derivates or ortho-diazo-naphthol derivates and ortho-carboxylated benzoyl-acetic acid takes place in the usual way by combining the ortho-oxy-diazo compounds with the

Dyestuff resulting from—		Dyeing of the sodium salt from acid bath on wool.	Dyeing of the copper salt from acid bath on wool.
The diazo derivate of—	And—		
$C_6H_3(OH)(NH_2)SO_3H$ [1:2:4]	Diketohydroinden	Yellow-brown	Red-brown
$C_6H_3(OH)(NH_2)SO_3H$ [1:2:4]	Indoxyl	Red-brown	Violet
$C_6H_3(OH)(NH_2)SO_3H$ [1:2:4]	6-Methyl-ketocumaran	Yellow	Violet
$C_6H_3(OH)(NH_2)SO_3H$ [1:2:4]	Peri-naphthindandion	Yellow-orange	Red-brown
$C_6H_3(OH)(NH_2)SO_3H$ [1:2:4]	3-Oxy-1-thionaphthen	Red-brown	Red-violet
$C_6H_2(OH)(NH_2)(SO_3H)COOH$ [1:2:4:6]	Peri-naphthindandion	Red-orange	Yellow-brown
$C_6H_2(OH)(NH_2)(SO_3H)COOH$ [1:2:4:6]	Diketohydroinden	Orange	Red-brown
$C_6H_2(OH_2)(CH_3)SO_3H$ [1:2:4:6]	3-Oxy-1-thionaphthen	Red-brown	Violet
$C_{10}H_5(NH_2)(OH)SO_3H$ [1:2:4]	Diketohydroinden	Red-brown	Violet
$C_{10}H_5(NH_2)(OH)SO_3H$ [1:2:4]	Peri-naphthindandion	Violet-brown	Bordeaux
$C_{10}H_5(NH_2)(OH)SO_3H$ [1:2:4]	3-Oxy-1-thionaphthen	Roseate	Pure violet-blue
$C_{10}H_5(NH_2)(OH)SO_3H$ [1:2:4]	6-Methyl-ketocumaran	Red-brown	Blue
$C_{10}H_4(NH_2)(OH)(SO_3H)NO_2$ [1:2:4:5]	3-Oxy-1-thionaphthen	Roseate	Black-violet
$C_{10}H_4(OH)(NH_2)(NO_2)SO_3H$ [1:2:4:6]	3-Oxy-1-thionaphthen	Brown-violet	Violet-black

said component in an alkaline solution. It is illustrated by the following example:

Example: The diazo derivative of 20 parts of sulfo-amido-salicylic acid

$$C_6H_2(OH)(NH_2)(SO_3H)COOH\ [1:2:4:6]$$

is poured into a concentrated solution of 21 parts of ortho-carboxylated benzoyl-acetic acid in water made alkaline by sodium carbonate. The dyestuff separated after combination is isolated by filtration, pressed and dried. It dissolves in water to orange-yellow and in concentrated sulfuric acid to pure violet solutions. On adding copper salts to the aqueous solutions their orange-yellow coloration turns to blue. It dyes wool in an acid bath brown tints.

In order to transform this oxy-azo dyestuff into its new copper compound 23 parts of the dyestuff are dissolved in 1,000 parts water and to this solution are added, at about 70° C., a solution of 13 parts of copper sulfate in 50 parts of water. The blue copper compound precipitates at once. After neutralization of the free sulfuric acid with sodium carbonate, the copper compound is separated by filtration, pressed and dried. It dyes wool in an acid bath blue tints fast to washing and to light.

If in the foregoing example the diazo derivative of sulfo-amido-salicylic acid is replaced by chloro-amino-phenol, 4-2-1, the sodium salt of the resulting ortho-oxy-diazo dyestuff dyes wool in an acid bath gray brown tints, while the copper compound derived from this ortho-oxy-azo dyestuff dyes wool in an acid bath dark-blue tints.

Marden, Orth & Hastings Rechartered.

The firm of Marden, Orth & Hastings, Inc., prominent manufacturers of artificial and natural colors, New York City, has revoked its charter under the laws of Maine and incorporated under the laws of the State of New York. The working capital of the company is listed at $1,950,000. The incorporators are: M. S. Orth, A. F. Burnham and E. N. Perkins.

Du Pont Opens New England Sales Branch.

E. I. Du Pont De Nemours & Company announce the opening of their dyestuff sales department for New England, at Turk's Head Building, Providence, Rhode Island, with George M. Snow, manager.

Growth of the American Dyestuff Industry.

Since January, 1915, the Bureau of Foreign and Domestic Commerce has done all in its power to stimulate and encourage the expansion of the American dyestuff industry. Great pains have been taken to keep in touch with its growth and to be in a position to inform the public, and especially the consumers of dyes, of the rate and nature of the expansion.

On August 15, the daily *Commerce Reports* contained an admirable *résumé* on this subject, which we here reproduce in full:

In response to inquiries for more complete information on the domestic industry than that given in the article on dyestuff production in the United States, which appeared in *Commerce Reports* for May 14, 1917, the Bureau of Foreign and Domestic Commerce on June 6 sent forms to all manufacturers of dyestuffs known to the Bureau, requesting their co-operation in securing more accurate returns. Practically the whole industry responded, the exceptions being a few minor firms and those just beginning operations and not in a position to calculate their probable output. Of 103 forms filled in and returned, all but three show in detail the capital invested and the variety, monthly production, and occasionally the quality of product manufactured by each firm, with frequent notations indicating the lines of experimental research now being conducted with a view to further development. On the remaining three forms reasons were given why only partial information was available.

Notices received during the year state that 12 firms have gone out of business or discontinued the manufacture of dyestuffs. Ten others have been eliminated by consolidations or absorbed by holding companies. An increasing tendency is shown in the industry to an amalgamation of interests among certain plants making crudes and intermediates with others producing finished dyestuffs, which will probably result in a more extended variety of colors at a decreasing cost of production. Several instances are noted where two or more allied corporations have apparently pooled their interests to facilitate the manufacture and marketing of their products, while one recent amalgamation includes some of the largest plants in the country.

Many of these great corporations have branches in various cities of the United States, and a few have established agencies in Latin-American capitals and in London, Paris, and Shanghai.

Capital Invested.

The capital stock given on 90 forms aggregates $158,913,650. According to notices of very recent incorporations, 22 new enterprises have a total capital of $4,112,000, making the total investment in the industry $163,025,650, as far as actual figures are available. This amount does not include the capital invested in dyestuff production by 10 firms, some of which are just beginning operations, while others state that they are not incorporated and have no capital stock, but are amply financed, or are owned by a single individual. These plants will probably be in full operation by 1918 and add several million dollars capital to the dyestuff industry. Another difficulty encountered in computing the total capitalization is the fact that a number of firms which formerly manufactured only explosives or a general line of chemicals state that their dyestuffs are by-products of recent development and that it is impossible to draw a line of demarcation to determine just what portion of their capital is invested in color production. No effort has therefore been made to supply these missing figures. If full and accurate data were obtainable, it is believed that the recent estimate of $200,000,000 invested in the domestic dyestuff industry, published in one of the trade journals, would be too conservative.

Twenty-one of these corporations have invested from $1,000,000 to $21,000,000 each, and 40 others have a capital ranging from $100,000 to $800,000.

Estimated Output of 100 Plants.

From figures submitted by the manufacturers the following totals of monthly production for the current year have been compiled:

Firms making returns.	Products.	Pounds.
22	Crudes:	
	Benzol, toluol, and some xylol and phenol......	*1,240,350
	Benzol, toluol, xylol, cumol, natural and synthetic phenol, cresol, naphthalene, anthracene.......	6,181,600
40	Intermediates	10,420,600
46	Artificial colors	5,000,000
13	Vegetable dyestuffs and extracts (including some tanning extracts not stated separately).........	8,183,500

---

* Gallons.

The above returns were submitted voluntarily and are as nearly complete as can be obtained by correspondence. For general purposes, they are fairly representative of the industry as a whole, though faulty from a statistical standpoint since, as stated, no returns were received from several minor firms so recently established as to be unable or unwilling to go into details of product and output, but whose combined production for the remainder of the calendar year would constitute only a small percentage of the whole. In some instances the figures for benzol are in excess of the amount used in the production of synthetic phenol. In this connection, it may be interesting to compare the above with published estimates by a leading authority on the subject that out of an approximate benzol production for 1917 of 220,000,000 pounds only 37,000,000 pounds would be used for dyes; and that there is a present indicated consumption of 12,000,000 pounds of naphthalene per annum in the manufacture of intermediates.

As stated by some of the larger firms, it is, of course, difficult if not impossible to give the exact amount of each article produced month by month, as the production varies according to the market. The demand for certain colors remains constant, while others are discontinued and the intermediates required in their manufacture are diverted to other purposes. The industry is still in the experimental stage, many products being manufactured on a semi-commercial scale, with processes not fully developed and qualities not yet standardized. In the case of the larger groups of amalgamations, the proper co-ordination of multiple phases of manufacture is being slowly perfected. The limited capital and productive capacity of newer plants frequently limit their operations to the filling of actual orders without any attempt to carry their products in stock.

Intermediates.

In round numbers, the 40 estimates of the monthly output of manufacturers of intermediates range from 1,000 to 2,000,000 pounds each. The monthly production of three factories reaches seven figures, and that of 15 others is expressed in six figures. Some of the factories make only the intermediates required for their own consumption in producing finished colors, some manufacture in excess of their own needs, while the efforts of others are confined to a line of intermediates only. The major portion of the total output of intermediates is probably consumed in the dyestuff industry, although a large amount, especially trinitrotoluol, falls in the category of explosives. There is a constant increase in the variety of intermediates and chemicals produced in this country for making colors. Dyestuff manufacturers are now producing large quantities of toluidines, resorcin, xylidine, dianisidine, naphthylamine, diphenylamine, tolidine, benzidine,, benzaldehyde, benzyl chloride, nitrobenzol, nitrotoluol, H-acid, phthalic, metanilic, sulfanilic, and naphthionic acids, naphtholsulfo acids, naphthylaminsulfo acids, and amidonaphtholsulfo acids, Schaeffer's salt, paranitraniline, dimethylaniline, and numerous others.

A glacial acetic acid plant of large capacity is expected to begin operation in September, and will be of the greatest assistance to the industry in general.

Artificial Colors.

The current monthly production of 46 manufacturers of finished dyes is at the rate of 5,000,000 pounds, or 60,000,000 pounds annually, individual outputs ranging from 600 to over 2,000,000 pounds each. This does not include any estimate from one plant of the first magnitude whose entrance into the industry has just been announced to the trade, or a score of smaller projects organized but not yet in full operation. The total shown includes only the figures given by the factories of actual production for the current calendar year, and makes no allowance for many plants now in course of construction which will soon be producing colors on a commercial scale, nor for the output of many dyes still in the experimental stage. These facts leave no doubt that our present annual domestic output greatly exceeds in quantity the entire consumption of artificial colors in the United States during the year 1914, estimated at 60,000,000 pounds, and is probably equivalent to the current annual consumption, which is considerably in excess of that for 1914. The returns further show beyond all question that a vast amount of technical talent and native inventive genius are now being concentrated on experimental research to perfect processes of production, improve quality, and enlarge the variety of dyes so as to include not only the more complex known colors currently used in Europe but possible new ones.

Coal-tar dyes in a variety of colors suitable for leather, textiles, straw, paper, inks, stains, pigments, varnishes, waxes, feathers, furs, and for many other purposes are now regularly obtainable from domestic sources. Several manufacturers carry full lines of direct, acid, basic, chome, oil, and sulfur colors, while others confine their efforts to improving and extending their output of particular groups. Prominent among the colors produced are nigrosines, indulines, triphenylmethane dyes, safranines, eosines, chrysoidines, rhodamines, rosanilines, direct fast reds, browns and yellows for cotton, fast chrome colors for wool, Sudan colors, basic violets, synthetic indigo, alkali blues for the silk and woolen industries and also for the lithographic trade, metanil yellow, methyl violet, methylene blue, benzopurpurine, benzo sky blue, primuline, naphthol green, rose bengale, gallocyanine, and special chrome and khaki colors.

Considerable attention is being given by about a dozen firms to developing as rapidly as the requisite intermediates are available the triphenyl-methane dyes, particularly fuchsine, methyl violet, methylene blue, magenta, and malachite green. Their output of many of these colors was not separately stated by some of the factories. The itemized figures given by only a few of the plants, however, show a monthly production of this series of colors amounting to 62,200 pounds. Of this quantity 18,200 pounds represent methyl violet and 13,450 pounds methylene blue. Two manufacturers specialize on the needed intermediates for these dyes.

There is a largely increased production and variety of reds, yellows, and scarlets, prominent among them being parareds for the printing trade, lithol red R, paramagenta, croceines, fast red Bordeaux for wool, acid reds and scarlets, wool scarlet, Biebrich scarlet, chrome yellow, metanil yellow, chrome orange, and brilliant orange. A wide range of fast reds, blues, greens, yellows, blacks, and grays for cotton is also available.

Colors now produced on a commercial scale that were not made in this country until recently are alizarin blues, browns, and yellows for calico printing, and for wool; paracolors for lakes or pigments, vat dyes (sometimes called indigoids) for cotton shirtings and ginghams, synthetic indigo, rhodamine, patent blue, and Biebrich scarlet.

Vegetable Colors and Extracts, Mineral Dyes, Lakes, and Pigments.

Present production and new developments contemplated include blacks and greens in natural colors for calico printers, a special logwood blue, special mordants for dyeing new shades in direct cotton colors, khaki dyes, cutch, archil, and logwood extracts, and cudbear powdered, orange, and lemon flavines, Osage orange in a variety of shades, American sumac extract, indigotin, and natural indigo shades. It is stated by several plans that their output depends on the domestic demand, ample facilities being available for a largely increased production at any time. Some operate at half capacity, while others are running 24 hours a day.

One firm is making sulfur brown (not a coal-tar product) on an extensive scale, while another company is producing mineral colors in standard shades for wool.

Soluble Prussian blue, Chinese blue, pigment brown, lakes in all the principal colors, paratoners, dry colors, and dyes for lake makers are specialties handled by different manufacturers.

Photographic Developers, Pharmaceuticals, Synthetic Perfumes, etc.

The urgent demand for photographic developers since the war began has greatly stimulated the production of hydroquinone, p-amidophenol, metol, amidol, and reducin. Single firms report monthly outputs of 1,000 to 15,000 pounds each of hydroquinone.

Manufacturers of coal-tar by-products are also marketing quantities of salicylic acid and its derivatives—particularly acetyl-salicylic acid (aspirin)—phenacetine, acetphenetidin, acetanilide, and other medicinals.

One maker of intermediates is producing the synthetic perfumes nerolin and bromelia. Another firm includes vanillin, used in flavoring extracts, in its list of products, and also saccharin.

Future Developments Contemplated.

The most striking feature brought out on the forms filled in by the dyestuff manufacturers is the marvelous growth of the industry and the plans in process of formation for its continued expansion in both domestic and foreign fields.

Announcement has been received of the entrance into the dyestuff industry of the leading company manufacturing explosives, fully equipped with a chemical and engineering staff, plant, and laboratory facilities, and an adequate commercial organization to meet the demand for colors on a vast scale. Other new plants in process of construction or to begin operations before 1918 are two for coal-tar crudes, one for anthracene, one for glacial acetic acid, four new buildings for aniline dyes, one for chrysoidine and methylene blue, one for nigrosine, induline and magenta, and one for nigrosine only. A producer of direct, acid, and chrome colors expects to double his present output of nearly half a million pounds annually inside of 12 months. One plant making methylene dyes is planning to double its capacity, two others making aniline colors will also double their capacity shortly, one manufacturer expected to have patent blue and fuchsine on the market after July, one of the larger corporations is now making auramine and lanafuschsine on a small scale and installing equipment for their increased output, and another contemplates the manufacture of primuline in considerable quantity. A producer of high-grade colors for silk is enlarging his factory and contemplates the early production of safranine and a suitable plant for the extensive manufacture of other aniline dyes.

Notations on a very large proportion of the forms returned show that experimental research is in progress on a great variety of products that are now being manufactured on a semicommercial scale with a view to increasing production as the processes are worked out in the different establishments.

Foreign trade opportunities published in *Commerce Reports* during the past few months from agencies in Norway, Spain, Brazil, Venezuela, and several from India, indicates foreign fields awaiting exploitation in this line, while recent sales of such products have been made in England.

Dyes and dyestuffs exported from the United States during the fiscal year ending June 30, 1917, were valued at $11,710,887 as compared with $5,102,002 for 1916. Beginning with July 1, 1917, the classification for monthly statements of exports will include under dyes and dyestuffs the subdivisions, alinine dyes, logwood extract, and all other shown separately.

A list of manufacturers in the United States producing coal-tar crudes, intermediates, artificial colors, and vegetable dyestuffs, and extracts may be obtained from the Bureau of Foreign and Domestic Commerce or its district and co-operative offices by interested users of such products.

Standards of Dye Strength in England.

Not only in the United States, but also in Great Britain, the question of standardizing dyestuffs has become a topic of keen discussion. In the following article *The Manchester Guardian* pictures very fairly the situation as it concerns both British producers and consumers of colors:

"Pre-War" Standards.

In a dyestuff case at the recent Assizes, counsel made great play with the phrase which has attained a significant currency in the trade—the "pre-war standard"; but the legal mind does not succeed as a rule, in throwing much light on subjects of this kind.

It appears that our German enemies had exported their dyestuffs to use in such a state of purity and uniformity that the standard cannot now be reached in spite of all our endeavors, and that no sample of dye that was not sanctified by the words "guaranteed pre-war standard" could be expected to be of first-rate quality. If that be so, it is not a very proud position to assume for a trade which has received national benediction and support, and which might almost be called now the spoiled child of British industry. Is it the fact that our manufacturers of dyes, handicapped as we know they are in some directions by lack of raw material, are deliberately adopting for such dyes as they can make a lower standard than that set up in pre-war times?

In the first place, it is a little amusing to those who knew something of the inner workings of the German firms, and who would not have been surprised in those days to have been comparing half a dozen different standards of the same thing or as many complaints of variations from standard, to find that "pre-war standard" is a name to conjure with. It is true that in such stock colors as direct cotton blacks and blues, benzopurpurine, sulfur blacks and alizarin, in which price conventions had been established, there was a fairly exact standardization. But in other quite common colors, such as wool scarlets and direct cotton pinks, there were variations of as much as 20 per cent between the regular standards of first-rate firms. Further, even in such a stock color as direct cotton black, one maker would offer one shade in two or even three different standard strengths, varying at least 50 per cent. Which of these standards now represents German orthodoxy?

It must be borne in mind, of course, that, for practical reasons and with one or two exceptions, dyestuffs are never marketed in the chemically pure state, but are "reduced" with various colorless diluents, which do not affect the coloring principle in any way. In other words, they are "standardized," and each maker adopts his own standard of strength, which, under pressure of competition, tends to approximate in relative price to the standards of other firms. Unfortunately for the dyer, a difference of a halfpenny per pound is much more obvious to him than a corresponding difference of 10 per cent in the strength, and, therefore, it not infrequently happens, and it has become a more common practice during the dyestuff famine, that a quantity of dye will be passed from hand to hand and further diluted in the process, or an odd parcel will be made up to a full hundredweight. The dealers have increased in number, while our sources of supply have decreased. This process of dilution is not in any way detrimental to the dye; it remains the same dye, and may rightly carry the same name, but it is not "pre-war standard." Where a mixing of dyes is in question, the matter is not quite so simple; insead of a comparatively innocent dilution, the dyer may receive an article which would be more correctly described as adulterated if the fastness and chemical properties, or even the shade of the dyeing, should be deteriorated by the admixture. Such an adulteration is much less easy to compute or even detect than a mere dilution, and in some cases the impurity may be present as a by-product of the manufacture, which, with more experience, the manufacturer may be trusted to eliminate. But in every event it is highly desirable that the dyer should make preliminary tests of every parcel of dye he proposes to buy, both to ascertain its coloring value and also that it will have the properties of fastness which he associates with the name under which it is sold. A dyestuff might be of full strength, and yet very far from "pre-war standard."

It is clear from these considerations that the phrase is only a very rough indication of the strength of the dyestuff, and indeed it is to be feared that it is very loosely used at times, and that under the abnormal price conditions ruling little consideration can have been paid to standards of any kind. Standards have no value apart from price, and standardization will only become of increasing importance again under the pressure of competition. In the meantime, the British manufacturer of dyes sets up his own standard of strength to work to. It may be comforting to the dyer to know that that British standard is comparable to a normal German standard, but more comforting still is the knowledge that the manufacturer supplies him at a price which is usually well below what the same dye would fetch in the open market at the present time. In other words, the manufacturer's output is well above the market standard of strength-value.

The Dyeing of the New Standard Khaki in England.

By C. M. Whittaker, B. Sc.

After two years and nine months of war the dyeing of khaki on loose wool is attaining a new significance because of the control of the wool trade by the Government. Manufacturers who have hitherto taken no part in the production of khaki cloth are willy-nilly now having to turn their attention to this line of business. Seeing that the State control of wool is making the purchase and use of wool for other purposes than military equipment increasingly difficult, there is no doubt that khaki orders will be a welcome means of keeping machinery running.

Vexatious Tests.—The dyers have at last been called into consultation on the best methods of obtaining the fastest results, taking into full consideration the uses to which the cloth will be put and the influences which it will have to resist. It is, therefore, sincerely to be hoped that many of the absurd tests to which khaki was submitted before the war will now disappear, never to be revived.

A big step in the improvement of the fastness of khaki has been taken in forbidding the use of logwood, gallocyanine and acid wool colors, because the small percentage of hematine or gallocyanine necessary in the dyeing of khaki was inevitably fugitive. The steps now being taken by the authorities will gradually eliminate other colors of which the fastness to light is not above suspicion. There are now ample supplies of other colors on the market, which are superior in fastness to light, and the continued use of the looser colors cannot be justified by the excuse that supplies are short.

The efforts of the authorities to obtain a standard shade of khaki of a standard fastness to light and milling will be slow in yielding results, and will require to be continued for some considerable time before they reach full fruition. Indeed, it is questionable whether the object to be attained is practically possible with several dyers and several manufacturers handling the wool. If six manufacturers were given wool of identical khaki shade, it is doubtful if two of them would produce the same ultimate result, owing to differences in their milling and finishing processes. Indeed, no one manufacturer will, for the same reason, deliver all his pieces to exact shade. There will have to be give and take in the matter, but there is no doubt the efforts now being made will effect a great levelling-up in the fastness of the khaki produced, though this will only be evident as the old contracts are worked off and deliveries of the new contracts under the new conditions begin to be made.

Single Bath Desirable.—The object of all these efforts is to reduce the multiplicity of shades demanded by the dyers—the number is surprisingly large—and so to obtain increased production to counterbalance the increasing shortage of labor. It also logically follows that the quickest method of dyeing should be adopted for the same reason, despite the opposition of those dyers who are still obsessed by the virtues of the chrome mordant because it is clear that a single bath method must beat a two-bath process bath from the point of view of production, labor, time, and steam.

The new khaki standard may be and is being produced in a variety of ways, but the following single bath recipe has been largely adopted, and is yielding good results on the big scale in a quick and cheap manner, while the results are fast both to milling and light. For 100 lb. cross-bred wool, weigh out:

4 lb. 5½ oz. Khaki Yellow WN paste.
1 " 6½ " Khaki Brown W paste.
1 " 3 " Khaki Green W paste,

and dissolve in water at the bottom of the cistern by boiling for ten minutes, then fill up, and add just before the wool is entered:

2 lb. bichrome,
5 " ammonium sulfate,

make slightly alkaline with ammonia before adding to the dyebath. Enter the wool not below 140° F., raise quickly to the boil, and boil one hour. It will naturally be understood that different qualities of wool may require slight alterations of the above qualities.

The observance of the following points will ensure good results every time:

The colors must be boiled for ten minutes in order to dissolve them completely; Khaki Brown W is the color which requires this.

Owing to Khaki Brown W commencing to fall out of solution below 100° F. the wool should always be entered well above this temperature, so that it does not cool the bath below 100° F., because if the Khaki Brown W has been allowed to fall out of solution it does not give the same color value.

While, in our opinion, ammonium sulfate gives the most level shades, its use is optional, and it may be replaced by acetic or formic acid. If these two acids are used, they should not be added until the bath has boiled half an hour. Sulfuric acid must be used with the greatest care, or else the shade will be turned too yellow. Some dyers use it toward the end of the dyeing fully to develop the green tone, but it must be carried out with extreme care.

When to Add Bichrome.—If it is desired to enter the wool boiling to get it under then keep off the bichrome and ammonium sulphate until the wool has been boiled under. The same precaution should be taken in machine dyeing in that the bichrome should not be added till the wool has become thoroughly saturated with the dye liquor, and the ammonium sulfate should be added after the bichrome has been pumped through for ten minutes. Extracted wool should always be neutralized before being dyed by this process. When dyeing limed or skin wool it should be noted that the shade takes longer to develop owing to the presence of the lime, and that it will in all probability require slightly more acid.

Finally, it must be noted that Khaki Green W must not be dyed in copper vessels, and that owing to its sensitiveness to copper we do not recommend its use for yarns or pieces. This sensitiveness to copper has made some people chary of using it on loose wool, but I would wish them to note that once the chrome lake of Khaki Green W has been formed it is not sensitive to copper. This may easily be tested by boiling a chromed khaki green shade with copper sulfate, and the copper will be found to have no effect on the shade. Wrap a piece of copper wire in flannel dyed with Khaki Green W and bichrome, and leave it in a strong soap solution over night; it will be found that it has no effect on the green.

It should also be noted that practically all the greens, blues, and blacks on the list of approved colors are distinctly sensitive to copper.—*Dyer and Calico Printer.*

The Bayer & Co. Works at Rensselaer.

The works at Rensselaer, N. Y., of the Bayer Co. are to be notably enlarged by the erection of three additional buildings. The output of dyes, as well as of synthetic medicinals by this company has done much to lessen the acuteness of the dyestuff shortage of the past two years. This increase in the facilities for manufacture will be welcomed by all depending upon the special group of colors made by the Bayer Co., which has hitherto specialized largely in the Nigrosines and Indulines, Chrysoidine, Bismarck Brown, and some of the standard triphenyl-methane dyes.

Colors for Army Uniforms.

Exceptional interest is felt in the requirements of the War Department as to color in connection with the vast number of uniforms now being ordered for our expeditionary force.

The *Textile World Journal* furnishes the following data on the subject which tend to show that the standard "olive drab" is produced in a thoroughly satisfactory manner by our domestic dyes, both synthetic and natural:

A certain firm manufacturing dyes has forwarded samples dyed with its colors to the local quartermaster's department to be submitted to the official tests. In this way it is hoped to obtain a definite statement as to the suitability of those particular dyestuffs. The wisdom of this procedure is emphasized by the representative of this firm, who states that there is no use recommending colors to customers as being available for meeting Government requirements unless definite knowledge of this fact is at hand. The tests used by the Government are soap and soda tests and 30 days' exposure to sunlight. The colors most in demand for producing an olive drab on wool to meet these tests are the chrome colors. These must be understood to be different from the actual alizarin dyes, or those produced from anthracene. There is a range of so-called "alizarin" and "anthracene" colors which have begun to be produced in this country. These are applied on a chrome mordant. From all reports, these have passed the tests satisfactorily. Despite the great demand for dyes of this nature, the few firms making them are keeping up fairly well with their orders.

As far as the use of natural dyes is concerned, a factor in the local market wrote to the Quartermasters Department inquiring if dyewoods were acceptable for Government orders. The answer was that so far there had been no embargo placed upon the use of natural dyes and that the only guide used by the department was the selection of dyed samples best meeting the standard requirements. In other words, it appears that the original method of dyeing is not closely scrutinized, but that judgment is passed upon the actual resistance shown by the samples submitted. Swatches are taken individually and must meet specifications. It is a known fact that osage orange has come up to Government specifications and that in some cases it has been found preferable to fustic, as there is a reddish constituent in the latter dyewood which is destroyed by the test. In all dyeing, however, much depends upon the care with which the fabric is colored, as the same products may give varying degrees of fastness when dyed under different conditions. This fact cannot be too strongly emphasized. Another natural dye which is being used, much to the surprise of factors in the dyewood market, is quercitron. This has generally been regarded as not suitable for the dyeing of fast shades, but it is known to have given satisfaction in the dyeing of blankets for Government use.

The Combination of the Leading German Manufacturers of Artificial Colors.

The necessity of unity and close co-operation on the part of the great German dyestuff companies, in order to recover to some extent the vast trade in all countries, which ceased soon after the beginning of the war, was recognized late in 1915. This necessity was intensified by the fact that powerful and promising efforts were under way to establish independent, self-contained, domestic color industries in our own country, in Great Britain, France, Japan and in other lands.

As a result, the leading firms entered into a very close combination, the natural effect of which will be to bring the rapidly growing coal-tar color industry in the United States, as well as the similar industries in other countries, face to face eventually with a single, giant organization, bent upon exerting every possible effort to regain the lost territory.

In a recent number of "Commerce Reports" (July 30) Consul W. C. Teichmann, who was stationed at Mannheim, across the river Rhine from the great works of the "Badische" Co., furnishes the following interesting description of the mechanism of this new combination:

Among the many economic changes that the present war conditions have brought about in Germany, the combination of German dyestuff interests, effected in 1915 and operating since January 1, 1916, is of special importance to Americans, because it means a formidable competitor for our infant American dyestuff industry in every foreign field, as well as in our own domestic market. In a smaller degree it also will bring future competition to other chemical industries in our country which have prospered during the war, as the German concerns that have been combined are also producers of pharmaceutical chemicals.

The rapid growth of the American dyestuff industry during the war has been given serious attention by the German concerns that formerly controlled our market, and has assisted in uniting these great rivals in Germany for mutual protection

Realizing the difficulties of reconquering the lost markets of the various foreign countries after the war, the German dyestuff manufacturers in the fall of 1915 organized a combine of the seven leading companies, which practically control the output, and pooled interests to the extent of securing uniform prices and wages, systematizing production, and also insuring a harmonious policy for all other interests involved. This implies uniformity in all endeavors to regain the former German foothold in foreign markets, and will apply to the new competition in the American market particularly. The importance of German exports in chemicals prior to the war can be seen from the statistics. Their annual averaged about $214,000,000, according to estimates of German trade organizations.

The concerns that entered the combine at that time, with their annual share of profits guaranteed during the first two years, were:

Companies.	Capital.	Average share of profits for two years. Per cent.	Later share. Per cent.
Hoechster Farbwerke	$11,900,000	24.82	25.02
Badische Anilin & Sodafabrik	12,852,000	24.82	25.02
Bayer, Leverkusen	......	24.82	25.02
Leopold Cassella & Co., Frankfurt	......	10.00	Not fixed
Aktiengesellschaft fuer Anilinfabrikation Berlin	4,712,400	8.04	8.14
Chemische Fabrik Griesheim	1,904,000	7.50	Not fixed
Chemische Fabrik vormals Weiler ter Meer			
Totals	......	100	100

Considerable difficulty was encountered in dividing the future profits, but the figures given were finally decided upon, together with an agreement, the essential features of which were as follows: It is to be binding for 50 years beginning January 1, 1916. While the separate organization of production of each concern is to be maintained, risks in business with foreign countries are to be jointly and proportionately carried by all members of the combination, accounting for the contemplated competition in foreign markets, in both "hostile and neutral countries" after the war. The distribution of the profits is to be based upon a certain "key" of calculation, however, not figuring on the entire production, but leaving out of consideration at first various special lines which are to be reckoned with after the expiration of a certain transitory period. For the Hoechster Farbwerke this involves separate profits from the manufacture of calcium carbide, and certain other products made therefrom; for the Badische Anilinfabrik, Bayer, and Berlin-Anilinfabrikation, the profits derived from the manufacture of synthetic ammonia and the respective inorganic compounds produced therefrom.

The "Badische" Co. has so successfully applied the Haber process of extracting nitrogen from the atmosphere and the production of synthetic ammonia therefrom since 1913, that while the ammonia output amounted to only about 30,000 tons in that year, it increased to 60,000 in 1914, 150,000 in 1915, and 300,000 in 1916, with an estimated figure of 500,000 tons for 1917.

The calculation of the table of profit percentages for the German combine was based upon an older "key" of the union of the Badische, Bayer, and Berlin. In the earlier combine the first two received 43 per cent. each, and Berlin 14 per cent. In order to enable the admission of the big Hoechster concern in the percentage to be made, that company increased its capital by $952,000, free from taxes and dues, at a market value of 200 per cent. per share. This favorable issue of new stock formed the equivalent for the transfer by Leopold Cassella & Co. of a part of its entitled percentage, according to its recently increased output, to the Hoechster concern, involving about 5 per cent. of the profits, so as to reduce the Cassella percentage from 15 to 10 per cent. In return Cassella receives in addition to the new stock of the Hoechster concern for a period of 10 years a special profit up to three-fourths of 1 per cent. of the total profits realized by the entire combine, as an indirect profit.

Another interesting subsidiary agreement was made with the large concern of Kalle & Co. in Biebrich on the Rhine. Kalle was included in the older Hoechster-Cassella agreement to the extent that the shares formerly in part held by Cassella were transferred to the Hoechster concern, which is now in possession of the entire capital of $1,428,000 of the Kalle Co., and hence also includes in its profit percentage the participation of Kalle & Co.

Adding to the 74.46 percentage of Hoechster, the Badische Anilin, and Bayer those of Berlin and of Cassella, the five concerns represent 92½ per cent. of the total profits of the new combine. Griesheim and Weiler ter Meer receive about 7½ per cent., probably yielding 6 per cent. to the latter, and 1½ per cent. to the former.

Thus a formidable understanding has been reached between the manufacturers of dyes and colors which can not fail to affect future prices and the export policies to be followed after the present war. Although German exports of chemicals received an effective setback as a result of the shipping hindrances encountered since the outbreak of the war, and the vigorous enforcement of the German embargo on many articles in these lines practically kept them out of the foreign markets altogether, it is predicted that nothing will be left undone which is needed in the attempt to reconquer the lost position.

It would seem that the loss of the large export business would have reduced the profits and dividends of the large companies that are in the combine, but contracts for army and hospital supplies have proved to be so valuable as to result in an increase rather than a diminution of profits since the war broke out, as shown by the figures for two of the concerns.

The Hoechster Farbwerke recorded net profits of $3,736,600 in 1915, as against $3,001,180 in 1914. Its dividends were 20 per cent. in 1915, 20 per cent. in 1914, and 30 per cent. in 1913. The Bayer Co. had net-profit figures of 4,969,440 for 1915 and $3,689,000 for 1914. Its dividends were 20 per cent. in 1915, 19 per cent. in 1914, and 28 per cent. in 1913. The Badische Anilinfabrik showed net profits of $4,519,540 for 1915 and $3,760,400 for 1914, the 1915 dividend, however, being 20 per cent. only, as against 19 per cent. for 1914 and 28 per cent. for 1913. Extensive enlargement of its plant and the rapid growth of its business at Oppau on the Rhine, where the process of nitrogen extraction from the atmosphere had necessitated the erection of large buildings, diverted some of the profits from dividend distributions; hence the lower dividends after the war broke out.

All German chemical concerns, small as well as large ones, have been favored with Government contracts for war supplies, so as to prevent their financial embarrassment. Industries which formerly manufactured goods in lines not available for war supplies were induced to change their plants somewhat in equipment so as to be able to furnish some kind of war material. Thus the absence of export facilities failed to destroy German industrial competitive power, and upon the conclusion of the war this factor must again be reckoned with.

Organization by combination of interests has not been confined to chemical lines, but is going on in various other industrial branches in preparation for tremendous efforts to regain foreign markets.

Reserve Stocks of Artificial Dyes in China

When the exportation of German synthetic dyes ceased in 1915, there was a most energetic hunt in out-of-the-way parts of the world for scattered stocks of colors, the owners of which could be tempted to part with them at elevated prices. Considerable amounts were found in Mexico, Central and South America. China, however, was the most productive field, and the quantity there secured was remarkably large.

The following report from the American Consulate General at Shanghai offeres an interesting picture of the general movement:—

"The declared exports of aniline dyes and indigo paste invoiced at the American consulate general at Shanghai for the United States during the years 1915 and 1916 and the first five months of 1917 were as follows:

Kind.	1915		1916		Jan. 1 to May 31, 1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Aniline dyes	1,301,312	$1,865,723	201.771	$540,227	2,000	$22,284
Indigo	2,441,821	2,482,129	406,466	546,471	....	....
Totals	3,743,133	$4,347,852	608.237	$1,086,698	2,000	$22,284

"These dyestuffs were all of German origin, as the trade was controlled by firms of that nationality up to 1914. When the war began and the original sources of supply were closed, consumers in the United States turned to other available stocks. The result was that during the next two years there were large exports from Shanghai, but at abnormal prices, as a number of Chinese firms cornered the market.

"Quotations on all grades increased many times and were subject to violent fluctuations. For fast indigo blue, in cases of 200 8-ounce cans, one firm charged 45 taels ($28.54 at $0.632) per case before the war, 270 taels ($155.28 at $0.5751) on January 17, 1916, and 400 taels ($301.20 at $0.753) on September

18, 1916; another firm, 450 taels (258.80 at $0.5751) on January 17, 1916, and 700 taels ($402.57 at $0.5751) on February 1, 1916.

"China magenta, in cases of 200 8-ounce cans, was quoted by one concern at 110 taels ($69.52 at $0.632) before the war, at 600 taels ($345.06 at $0.5751) on January 17, 1916, and at 1,300 taels ($978.90 at $0.753) on September 8, 1916; another quotation was 750 taels ($431.33 at $0.5751) on January 17, 1916, and 950 taels ($546.34 at $0.5751) two days later.

"The examples given show not only the fluctuating and generally increasing prices of silver, but also the wide differences in quotations by separate firms on approximately the same dates, a proof of the uncertainty and instability of the market.

"The almost entire disappearance of these goods from the list of exports to the United States since the first of the present year may be ascribed to (1) the high rate of silver, resulting in increased gold prices (unfavorable to exports); (2) the excessive prices, in local silver currency, demanded by the Chinese merchants now holding stocks; (3) the prevailing high freight and insurance rates and lack of shipping space; and (4) the probable increase in the domestic production of dyestuffs in the United States."

NATURAL DYES

The Manufacture of Archil Extract in the United States.

The use of the natural dyestuff archil (orchil, orseille) dates far back. Despite the pronounced fugitive character of the bright red and violet shades which it yields there is a constant and regular demand for the dye, chiefly for use in combination with other colors on wool and silk. Fabrics and yarn dyed with perfectly fast colors seem to gain very materially in luster and brilliancy when passed through an archil bath. There is, also, our extended use in producing certain brown shades, both in dyeing and calico printing, which are fairly permanent to light.

The coloring matter is obtained from various lichens, *Roccella tinctoria, Roccella fuciformis, Roccella Peruviana,* and allied varieties, which grow freely on rocky sea coasts, notably in the Mediterranean, in the Azores, Mozambique, Zanzibar, Madagascar and Ceylon The raw material is pressed into bales and sent to European centers of distribution. Prominent among the latter are London, Havre, Lisbon and Hamburg.

The extraction of the coloring principle in a form suitable for the dyer's use has been localized chiefly in England, France and Switzerland. It is found in commerce in the form of liquid extracts of varying strength, of paste, and of the dry powder known as cudbear.

It appears that the peninsula of Lower California is an abundant source of the lichens in question. American capital has secured control of the best locality. Instead of shipping the crude material to Europe it is sent to San Diego, California, near which the Lower California Chemical Co. has erected a large plant for the purpose of extraction.

The most promising source of archil in Lower California is in the region about Magdalena Bay, where *Roccella Peruviana* is found in great quantities growing upon shrubs and bushes exposed to the spray and mist of the Pacific ocean. Scattered occurrences of the parasitic moss-plant are found all along the Pacific slope, but nowhere in such abundance as in the so-called "Zona orchillera" around Magdalena Bay. In this tract about 100,000 tons of the plant are ready for harvesting. It reappears rapidly. Within three or four years after a tract has been picked clean a new crop is ready for collection.

The operation of harvesting is quite simple. The lichen is torn from the trees or bushes upon which it is found and allowed to dry upon the ground for a few days. The daily amount collected by a laborer ranges from 100 to 200 pounds. When well dried it is pressed into bales of 550 to 650 pounds each, and is ready for shipment. Prior to the war archil collected at this point sold for $23 per ton, including freight to European ports. Prices for the same material on the Peruvian coast, f. o. b., ranged from $22 to $48 before the war.

This one source is sufficient to supply all of the archil extract used currently in the United States, which amounted to about 250 short tons annually prior to 1915, but which has been materially augmented since then.

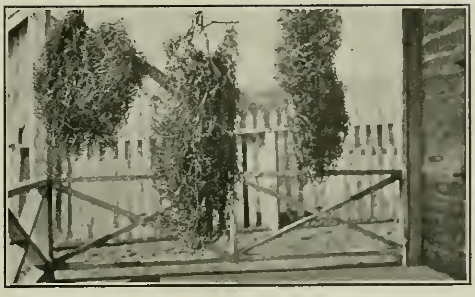
The plant of the Lower California Chemical Co., for the extraction of the coloring matter, is located at National City, near San Diego, Cal. The operations are relatively simple, but require exceedingly careful supervision in order to assure purity and uniformity of product.

As in the case of natural indigo the coloring matter is not present as such in the lichen, but results from a process of oxidation. This is carried out with free exposure to the air, but requires the simultaneous action of ammonia. The works of the company are equipped with capacious vats, in which the archil plants, after having been carefully cleaned and ground to a coarse powder, are allowed to remain for several weeks in contact with very dilute ammonia and under constant stirring.

The orsellinic acid in the lichens, as a result of the process of fermentation which takes place, splits off CO_2, and forms orcinol, or m-dihydroxytoluene, $C_6H_3(CH_3:OH:OH = 1:3:5)$. This, in turn, in the presence of ammonia, changes into orcein, which appears to be a mixture of reddish $C_{28}H_{24}N_2O_7$ and yellowish

S. S. "Catarina" Loaded with Archil for Shipment to San Diego

Camp of Archil Collectors



The Archil Plant

Receiving and Weighing the Archil Plants at the Camp

Warehouse at Magdalena Bay, Showing Presses and Baled Archil

Archil Factory at Magdalena Bay

$C_{21}H_9NO_6$, along with a coloring matter similar to litmus.

The thick paste remaining in the vats forms the simplest commercial article. Dried and powdered it is known as cudbear. The paste is also extracted with water, and the reddish-violet solutions, in various degrees of concentration—the strongest being thick syrups—are preferred by many dyers.

It is a source of satisfaction to see this manufacture of the well-known vegetable coloring matter firmly established on American soil, and we confidently look forward to such an expansion of the industry that its output may contribute to the growing volume of our export of American-made dyes.

We are indebted to Mr. C. W. Hill, president of the company engaged in this undertaking, for several views illustrating the collection of the raw material.

T. H. N.

Autumnal Foliage as a Source of Dye.

The peculiar conditions of the past three years, in connection with the supply of coloring materials for textile and allied industries, have stimulated to a remarkable degree the search for new dyes in the vegetable kingdom, as well as the more thorough and intelligent utilization of those already well known to the colorist. In South America and in India the efforts have been numerous in this field. In the United States they have been not less so, although in most cases little publicity has accompanied the search.

Osage orange is the most striking example of the development of an entirely new source of a dye, already well known in the fustic of tropical America. Of notable importance is the wide-spread demand for the Quercitron of the American black oak, and the more general recognition of its helpful and permanent qualities in a comprehensive scheme of dyeing.

The most recent advance in this province is the detection of a valuable dyestuff in the autumnal foliage of our American forests, more especially in that of the maple. The dried leaves of this tree, when subjected to the customary methods of extraction by boiling water, yield a product constituting in the dry form about 18 per cent of the original weight. This product is a genuine dye, imparting to animal fibers beautiful shades of brown, of absolute fastness to light, washing, etc., without the use of a mordant. The range of tints is increased by the use of the ordinary mordants. The ease of dyeing without the use of metallic mordants is evidently due to the presence in the color extract itself of a considerable amount of tannic acid.

The application to cotton is not productive of as pronounced tinctorial results, as in the case of wool or silk, but there appears to be a distinct field here for its use, especially in combination with other coloring matters.

In connection with silk dyeing, this new material promises to play an important role for purely weighting purposes. Silk fibers absorb an appreciably larger amount of the maple extract than is the case with gambier, now so largely used for weighting. The color imparted to the silk is somewhat darker than in the case of gambier, otherwise the fiber adapts itself with the same ease to the subsequent operations involved in dyeing and finishing.

An interesting fact in connection with this new color is that the discovery was made by a woman, Mrs. Edith O'Neill MacDonald, of St. Regis Falls, N. Y. She has christened the product "Gold Leaf," a picturesque but quite appropriate designation, for the substance, especially for some of the lighter shades obtained in its use.

Mrs. MacDonald is a lady well-known in northern New York as a writer and speaker. Her own account of the discovery is of so much interest that we reproduce it:

"I canvassed the wants of America as set forth in the newspapers and finally decided the dye shortage at the time was the most acute situation (we had potatoes then), and the most possible and probable field of discovery. Chronic inventors possess a power of concentration that amounts to genius. Genius is only acute observation and powerful concentration on a given subject. But anybody with an average amount of intuition and the power to adjust the mental focus to one particular field of vision can indulge in acute attacks of invention. Having decided to have such an attack, I adjusted my mental focus on the dye field. I looked at everything through color glasses, so to speak. I read newspapers, magazines, and technical journals and searched my immediate surroundings for something that looked like dye.

"Then there came a north country October windstorm that tore all the leaves from the trees. Following it, a continued rain saturated them and glued them to the cement walks. Finally the sun dried them, and gentle breezes lifted and whirled and scattered them into sheltered corners. But instead of 'Footprints on the Sands of Time,' they left leaf-prints of this dye of mine. Thousands of people in the north country walked over these prints, and have walked over them for many years. I have myself, and seen them only as an artistic but empty outline. But this day my mind was adjusted to a dye focus, and at sight of the dainty brown prints I leaped at the possibilities they might contain. I gathered an armful, and in twenty-four hours I had an array of tints of gold that rivaled the sunshine—gold that would neither boil out, wash out, nor fade out, though I tried it in weeks of sunlight.

"Immediately I communicated with the dyestuff expert of the Bureau of Foreign and Domestic Commerce, whose opinion is so highly appreciated in such matters. Under his tutelage I acquired a more or less intimate and accurate knowledge of dyeing and textile chemistry. I mastered the use of mordants and six weeks later I had finished a demonstration that contains every possible shade ranging from a shimmering, glistening gold to the darkest seal brown, as well as grays and taupes. In this demonstration I used wool, silk, velvet, feathers, and paper, also demonstrating the use of the solid extract as an ink and water-color paint. The Patent Office examined the dye, tested it, and allowed my claim without delay."

This new color may be of pronounced assistance in view of the rapidly increasing demand for khaki shades. The one limitation upon its otherwise so easy manufacture is the fact that the abundant raw material can be collected from our maple forest only during the late autumn, after the chlorophyll present in the leaves has undergone radical transformation.

In interesting connection with the above we quote the following from a recent issue of *The Chemical Trade Journal* of London:

H. M. Consul-General at Seoul has forwarded particulars regarding the production of dyestuffs in Corea from the leaves of a species of maple tree, known to Coreans as the "Shinnamu." This tree is very common throughout Corea, and, according to the Director of the Central Technical Institute of the Governor-General of Corea, is not found elsewhere, except to a certain extent in that part of Manchuria immediately to the north of the Yalu River. The official referred to states that if the dye should prove of commercial value, it could be produced in very large quantities in Corea. The cost of production, according to the same authority, is approximately 25 sen (about sixpence) per pound. With colors obtained from the "Shinnamu" extract cotton goods can be dyed black, indigo, dark gray, and khaki. In dyeing silk and pongees, black only can be utilized, and the chief value of the extract is for loading purposes, silk yarns or materials becoming over 30 per cent heavier after treatment. H. M. Consul-General has also forwarded a sample of the "Shinnamu" dye, together with samples of cotton yarns dyed with it, in four colors.

"Particulars of the methods of using a yellow or khaki dye produced in Corea from the flower of the "Enju" or "Pagoda Tree" have also been received from H. M. Consul-General. This tree is said to be very common both in Corea and in the district of Manchuria immediately north of the Yalu River. Silk, wool, and cotton are all susceptible of treatment with this dye, a sample of which, together with specimens of various threads and yarns treated with it, have been furnished.

"The above-mentioned particulars may be consulted, and the samples referred to inspected, at the Department of Commercial Intelligence, 73, Basinghall Street, London, E. C. 2."

There is no mention in the above of the source of dye being limited to autumnal foliage. The value of the extract for loading or weighting silk would indicate, however, a close relationship with the American product.

SYNTHETIC DRUGS AND PERFUMES PHOTOGRAPHIC DEVELOPERS

Salvarsan of Domestic Make.

Prior to the war the world depended upon the great chemical works at Hoechst, in Germany, for its entire supply of the important synthetic medicinal, salvarsan. A few consignments to this country were permitted to pass by the British Government. The total amount thus received was far below the quantity normally required by the medical profession, and the inability to secure supplies has caused serious hardships.

Under the circumstances, Mr. Herman A. Metz, of Herman A. Metz & Co., the American agents of the Farbwerke-Hoechst Co., took the necessary steps to have the manufacture of the compound placed upon an industrial basis in this country. A suitable plant was erected at Brooklyn by a new organization, termed the H. A. Metz Laboratories, Inc., and the requisite technical staff was secured.

After overcoming the inevitable difficulties attendant upon the establishment of an exceptionally delicate and complicated manufacturing process, the new company is now in a position to supply salvarsan in commercial quantities. It recently issued the following statement:

"Salvarsan is now being made in our new Brooklyn laboratories under the supervision of Dr. G. P. Metz, who was instructed in the process of manufacture at Hoechst, Germany. It corresponds in every detail to the standards set by the late Dr. Paul Ehrlich, and is the only product made by the processes used at the Hoechst works.

"As is well known, the slightest irregularity in the process of manufacture of salvarsan may cause the formation in it of toxic by-products. In order to protect the public and ourselves against the effects of any accidental irregularities in manufacture, we ascertain toxicologically whether or not each lot of salvarsan prepared by us is free from such toxic by-products. This knowledge is obtained for us by the head of the Department of Biological Chemistry in one of our leading university medical schools, who bears the same judicial attitude to our preparations that Prof. Ehrlich did to the standard German preparations, and who subjects our preparations to biological tests that he considers more rigorous and comprehensive than those adopted for this purpose by Prof. Ehrlich, himself.

We will market only such lots of salvarsan as have been thoroughly tested by this biological chemist and pronounced by him to be free from injurious by-products. The name of our biochemical collaborator will be given to any who may wish to consult us regarding the nature and results of his tests of our preparations.

"This American-made salvarsan will be sold to the medical profession direct, until local agencies have been satisfactorily established."

Antipyretic Stimulants

Albert D. Barr, of McHale, Arkansas (Amer. Pat. 1,235,278, of July 31, 1917) describes the preparation of a class of stimulating, antipyretic crystalline compounds, obtained by bringing into combination coal-tar antipyretics of the acetanilide type, with organic acids, such as citric acid, and vegetable alkaloids possessing stimulant properties.

The method is illustrated by the following example:

To 6600 grains of citric acid ($H_3C_6H_5O_7$) add about a pint of water and heat to the boiling point. To this solution is added 4460 grains of acetanilide ($C_6H_5NH.C_2H_3O$) or its equivalent and the compound thus formed is boiled for about thirty minutes.

To this is added 7000 grains of caffein ($C_8H_{10}N_4O_2$) and the mass is boiled for two and one-half hours, care being taken to add, from time to time, the water lost by evaporation.

At the end of this time the solution is placed over a water bath and evaporated until the compound weighs about 18,060 grains, at which time it has become a true chemical compound of thick, syrupy consistency. It is then set aside in a cool place, and allowed to crystallize for from three to six weeks. The result is a true chemical combination containing acetanilide, citric acid and caffein molecules ($C_6H_5NHC_2H_3O$, $H_3C_6H_5O_7$, $C_8H_{10}N_4O_2$) in the proportions of ten parts of acetanilide, 14.8 parts of citric acid and 15.7 parts of caffein. On analysis it yields 24.7 per cent. acetanilide; 36.5 per cent. citric acid; and 38.8 per cent. caffein. It dissolves in about its own weight of water and is slightly hygroscopic during warm weather. The medicinal adult dose is from five to twenty-five grains and it is advantageous in all pathological conditions where there is a rise of temperature above 100°.3 F.

Increased Cost of Perfumery.

There has been a notable increase in the cost of all the materials entering into the cost of manufacturing artificial perfumes during the past three years. The following quotations of pound prices for June, 1914 and 1917, show the effects of limited supplies:

	June, 1914	June, 1917
Amyl salicylate	$1.28	$2.50
Benzaldehyde	.50	4.50
Oil of bitter almonds	4.00	12.50
Benzyl benzoate	.80	10.00
Phenyl-ethylic alcohol	10.00	54.00
Phenyl-acetic aldehyde	20.00	60.00

New Arseno-Phosphorus Compounds.

A new series of arseno-phosphorus compounds, presumably for therapeutic use, can be obtained from amino-phenylarsinic acid, by treatment with phosphorus oxychloride, according to the recent patent of A. Mouneyrat, of Paris, France (Amer. Pat. 1,232,373, of July 3, 1917). These compounds form yellowish powders and are soluble in dilute solutions of sodium carbonate.

MISCELLANEOUS

Manufacture of Benzyl Chloride.

The industrial production of benzyl chloride, $C_6H_5.CH_2Cl$, has never been perfected so as to result in a yield approaching at all the theoretical figures. The customary operation is to conduct chlorine upon the surface of boiling toluene, which absorbs it rapidly, until the toluene used shows an increase in weight of 38 per cent. The product is washed with water, and is then separated by fractional distillation from unaltered toluene, and from benzylidene dichloride, $C_6H_5.CHCl_2$, and benzotrichloride, $C_6H_5.CCl_3$, both of which are formed simultaneously and in considerable amount.

It is difficult to secure commercial benzyl chloride of any high degree of purity. The three substances above mentioned, and often various chloro-toluenes, are present in varying quantities in almost all cases.

Considerable interest is attached to the process recently patented by James B. Conant of Cambridge, Mass., and assigned to the Semet-Solvay Co. (Amer. Pat. 1,233,986, of July 17, 1917), in which benzyl chloride is produced by the formation of nascent chlorine in toluene.

The method is described as follows: The toluene to be chlorinated is placed in any suitable container provided with a stirrer and cooling coil. Bleaching powder is then mixed with the toluene in the proportion of one part of bleaching powder to two parts of toluene. It should preferably contain thirty-five per cent (35%) or more of available chlorine. Sulfur dioxide gas or a mixture of sulfur dioxide gas and nitrogen is next introduced into the mixture by bubbling it in through pipes entering the bottom of the container. Instead of sulfur dioxide there may be used any gaseous acid or acid anhydrid. Considerable heat is evolved by the subsequent reaction but the temperature at which the toluene is kept is of no importance for the success of the reaction. A return condenser may be fitted to the apparatus to prevent any loss of toluene. When between .1 and .5 of a pound of sulfur dioxide per pound of bleaching powder has been introduced, the reaction is finished. The toluene and benzyl chloride are now distilled off by means of steam from the solid residue, the toluene coming over first. The last portion consisting of toluene and benzyl chloride may be separated by fractional distillation. The yield is about one pound of benzyl chloride from every three to six pounds of bleaching powder, depending largely upon the quality of the bleaching powder. The unchanged toluene is recovered and is used over again, while the solid residue, consisting largely of calcium sulfate, may be readily washed out of the apparatus and thrown away.

It is claimed that the process has the following advantages over the ordinary procedure, viz., the reaction is much faster, thus requiring a less bulky apparatus for a given output; it does not necessitate the keeping of toluene at its boiling point; it does not require the use of chlorine gas, which is a corrosive substance, thus making a much simpler apparatus possible; it produces none or a small amount of chlorotoluene; it produces only a trace of other chlorination products of toluene; no corrosive hydrochloric acid gas is given off in the reaction.

Theft of Dye Formulas.

The theft of dye formulas claimed to be worth several million dollars to the Martin Dyeing and Finishing Company, Bridgeton, N. J., led to the arrest, in Philadelphia, July 5, of Louis Hihn. The Martin company has been working on United States Government contracts, engaged in the dyeing and finishing of cloth for uniforms for the new National Army. After the dye formulas were stolen, the dye plant, it is said, was greatly hindered in its work.

New Benzol Plant.

One of the largest benzol-recovery plants in the country is in course of erection at Duluth by the Minnesota Steel Co. The cost is placed at $500,000. The plant will be in operation during the coming winter.

Mr. James J. Bajda, lately chief dye chemist for B. Heller and Co., has been appointed superintendent of the color works, now under construction by the Block Chemical Laboratories.

CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS

CRUDES.

Anthracene, 80 p. c.	lb.	.10	— 14
Benzol, pure, water white	gal.	.52	— .55
Benzol, 90 p.c.	gal.	.53	— .54
Cresol, U. S. P.	lb.	.18	— .20
o-Cresol	lb.	.30	— .35
Cresylic acid, 95-97 p.c.	gal.	1.00	— 1.05
Cumene (pseudo)	lb.	—	— —
Dip oil, 20 p.c.	gal.	.29	— .30
Naphthalene	lb.	.09	— .09½
Flake	lb.	.09	— .09⅛
Balls	lb.	.10¾	— .11
Phenol (carbolic acid), U. S. P., cryst., drs.	lb.	.40	— .45
Pitch, various grades	ton	8.00	—20.00
Solvent naphtha, water white	gal.	.18	— .22
Solvent naphtha, crude, heavy	gal.	.13	— .16
Toluol, pure, water white	gal	1.80	— 2.00
Toluol, commercial, 90 p.c.	gal.	1.75	— 1.85
Xylene, pure	gal	1.00	— 1.25
Xylene, commercial	gal.	.35	— .40

INTERMEDIATES AND EXPLOSIVES.

Amido - naphthol - disulfonic acid (H-acid; 1.8.3.6)	lb.	3.50	— 4.00
Amido-naphthol-sulfonic acid.	lb.	—	— 1.75
p-Amido-phenol	lb.	4.00	— 4.50
p-Amido-phenol hydrochloride,	lb.	5.00	— 5.50
Amino-azo-benzene	lb.	1.75	— 1.85
Aniline oil	lb.	.28	— .30
Aniline salts	lb.	.33	— .35
Aniline for red	lb.	1.10	— 1.15
Anthraquinone	lb.	—	— —
Benzaldehyde	lb.	4.00	— 4.50
Oil of bitter almonds	lb.	12.50	—13.50
Benzidine	lb.	1.85	— 1.95
Benzidine sulfate	lb.	1.60	— 1.70
Benzoic acid	lb.	5.50	— 8.00
Crude	lb.	3.00	— 3.50
From gum	lb.	7.25	— 7.50
Benzylchloride	lb.	1.75	— 2.00
Chloro-benzene	lb.	.28	— .30
Cumidine	lb.	—	— —
Diamido-phenol	lb.	9.00	—10.00
o-Dianisidine	lb.	—	— —
Dichloro-benzene	lb.	.20	— .25
o-Dichloro-benzene	lb.	.15	— .16
p-Dichloro-benzene	lb.	.21	— .24
Diethyl-aniline	lb.	3.00	— 3.50
Dimethyl-aniline	lb.	.60	— .62
Dinitro-benzene	lb.	.33	— .35
m-Dinitro-benzene	lb.	.45	— .50
Dinitrochloro-benzine	lb.	.44	— .48
Dinitro-naphthalene	lb.	.60	— .70
Dinitro-phenol	lb.	.60	— .62
Dinitro-toluene	lb.	.57	— .62
Diphenylamine	lb.	.90	— 1.10
Ethyl-aniline	lb.	1.25	— 1.40
Hydroquinone	lb.	2.00	— 2.10
Hydrazobenzene	lb.	1.50	— 2.00
Naphthionic acid, white	lb.	1.75	— 1.85
a-Naphthol	lb.	2.25	— 2.90
b-Naphthol	lb.	.65	— .70
Sublimed	lb.	.75	— .85
a-Naphthylamine	lb.	.75	— .80
b-Naphthylamine	lb.	1.75	— 2.00
Sublimed	lb.	2.75	— 3.00
p-Nitraniline	lb.	1.25	— 1.35
Nitrobenzene	lb.	.18	— .20
Oil of Mirbane, ref.	lb.	.19	— .20
o-Nitrochloro-benzene	lb.	.50	— .56
Nitro-naphthalene	lb.	.44	— .65
Nitrotoluene	lb.	.55	— .60
o-Nitrotoluene	lb.	.90	— 1.00
p-Nitrotoluene	lb.	1.40	— 1.50
m-Phenylene-diamine	lb.	1.15	— 1.25
p-Phenylene-diamine	lb.	3.50	— 4.00
Phthalic anhydride	lb.	6.40	— 6.50
Picric acid, kegs	lb.	.75	— .80
Resorcinal, cryst., U. S. P.	lb.	16.00	—17.00
Technical	lb.	6.00	— 7.00
Salicylic acid, U. S. P.	lb.	1.45	— 1.50
Sulfanilic acid	lb.	.33	— .35
Tetra-nitro-methyl-aniline	lb.	—	— 2.50
Tolidine	lb.	3.00	— 3.50
Toluidine	lb.	.80	— .85
o-Toluidine	lb.	.85	— .95
p-Toluidine	lb.	2.00	— 2.25
m-Toluviene-diamine	lb.	1.70	— 1.75
Xylidine	lb.	.75	— .85

SYNTHETIC MEDICINALS, FLAVORS AND PERFUMES.

Acetanilide C. P., bbls.	lb.	.50	— .55
Acetphentidine	lb.	13.00	—14.00
Acetyl-salicylic acid, bulk	lb.	—	— 3.50
Ammonium benzoate	lb.	11.00	— —
Ammonium salicylate	lb.	1.60	— 1.63
Antipyrine, bulk	lb.	23.00	—24.00
Bismuth phenolsulfonate	lb.	—	— 9.30
Bismuth salicylate	lb.	—	— 3.15
Bismuth sub-benzoate	lb.	7.50	— 8.00
Bismuth subsalicylate, basic, U. S. P.	lb.	—	— 5.20
Calcium sulfocarbolate	lb.	1.40	— 1.45
Ethyl benzoate	lb.	—	— 8.00
b-Naphthol benzoate	oz.	—	— .90
Phenacetin (Bayer)	oz.	—	— 2.40
Phenolphthalein	lb.	15.00	—16.00
Potassium salicylate	lb.	2.90	— 2.95
Saccharin	lb.	39.00	—47.00
Salol	lb.	1.97	— 2.05
Sodium benzoate, granulated, U. S. P.	lb.	2.00	— 2.25
Sodium salicylate, U. S. P.	lb.	.85	— .95
Wintergreen oil synthetic, U. S. P.	lb.	.75	— .80
Zinc salicylate	lb.	—	— 3.25

PHOTOGRAPHIC DEVELOPERS.

Adurol, 16-oz. bottles	ea.	—	—10.00
Agfa (intensifier) 2-oz. bottle		—	— .40
Amidol, 1-oz. bottle	oz.	.65	— .75
Dianol, 1-oz. bottle	oz.	—	— .80
Edinol		—	— —
Eikonogen	oz.	—	— .45
Glycin, 1-oz. bottle	oz.	—	— .80
Hydroquinone	lb.	2.00	— 2.10
Metacarbol		—	— —
Metol	oz.	—	— —
Monomethyl-p-amido-phenol (identical with metol)	oz.	—	— 3.50
Nerol (identical with amidol), 1 oz.	oz.	—	— .30
Ortol, 1-oz. bottle	oz.	—	— .80
Pyrogallic acid, crystals	lb.	2.95	— 3.15
Rhodol	lb.	—	— —
Rodinal, 3-oz. bottle	ea.	—	— .75

ARTIFICIAL COLORS.

Acid Black	lb.	2.00	— 2.60
Acid Blue	lb.	3.00	— 4.00
Acid Brown	lb.	3.25	— 4.00
Acid Fuchsine	lb.	6.50	— 7.50
Acid Green	lb.	3.50	— 4.00
Acid Orange	lb.	.95	— 1.25
Acid Orange II	lb.	1.20	— 1.40
Acid Orange III	lb.	1.50	— 2.00
Acid Red	lb.	2.75	— 3.00
Acid Scarlet	lb.	4.00	— 4.50
Acid Yellow	lb.	2.25	— 2.50
Alizarin Blue	lb.	9.00	—10.00
Alizarin Blue, bright	lb.	9.50	—11.00
Alizarin Blue, medium	lb.	8.50	— 9.00
Alizarin Orange	lb.	6.00	— 8.50
Alpine Red	lb.	5.00	— 6.00
Alpine Yellow	lb.	6.50	— 7.50
Auramine	lb.	4.00	— 5.00
Azo Carmine	lb.	6.25	— 6.75
Azo Yellow	lb.	6.00	— 7.00
Azo Yellow, red shade	lb.	4.75	— 5.50
Aurine	lb.	2.60	— 3.00
Bismarck Brown Y	lb.	1.60	— 2.00
Bismarck Brown FF conc.	lb.	2.00	— 2.50
Bismarck Brown 3 R	lb.	2.50	— 3.00
Bismarck Brown R	lb.	1.20	— 2.75
Bright Red	lb.	3.00	— 3.75
Chrysamine Yellow	lb.	2.25	— 3.00
Chrysoidine	lb.	2.10	— 3.00
Chrysoidine R	lb.	2.00	— 3.00
Chrysoidine Y	lb.	1.75	— 2.00
Congo Red	lb.	4.50	— 5.00
Crystal Violet	lb.	7.50	— 8.00
Direct Acid Orange	lb.	1.10	— 1.25

Direct Black	lb.	1.00 — 2.00
Direct Blue	lb.	2.60 — 3.00
Direct Sky Blue	lb.	5.00 — 6.00
Direct Brown	lb.	2.80 — 3.25
Direct Bordeaux	lb.	3.00 — 4.00
Direct Fast Red	lb.	2.55 — 3.00
Direct Red	lb.	2.75 — 3.50
Direct Yellow	lb.	2.00 — 4.00
Direct Fast Yellow	lb.	3.00 — 4.00
Direct Violet	lb.	2.50 — 3.50
Eosin	lb.	10.00 —15.00
Fast Red, 6B extra	lb.	4.00 — 5.00
T extra	lb.	— — 2.00
Fast Scarlet	lb.	1.75 — 2.35
Fuchsine	lb.	7.50 —12.00
Fur Black, extra	lb.	2.50 — 3.00
Fur Brown B	lb.	3.75 — 4.50
Fur Brown GG	lb.	6.25 — 8.00
Green Crystals	lb.	10.50 —11.50
Indigo 20 p.c. paste	lb.	1.80 — 2.00
Indigotin	lb.	4.50 — 5.00
Induline	lb.	1.90 — 2.50
Magenta	lb.	10.00 —12.00
Malachite Green	lb.	11.00 —12.00
Metanil Yellow	lb.	2.50 — 3.00
Medium Green	lb.	3.00 — 4.00
Methylene Blue, tech	lb.	4.00 — 5.00
Methyl Violet	lb.	4.00 — 4.75
Naphthol Green	lb.	3.50 — 4.50
Nigrosine, oil sol	lb.	1.00 — 1.50
Nigrosine, sp. sol	lb.	.90 — 1.00
Nigrosine water sol., blue	lb.	1.00 — 2.00
Jet	lb.	1.35 — 1.50
Naphthylamine Red	lb.	6.50 — 7.00
Oil Black	lb.	1.80 — 2.10
Oil Green	lb	2.00 — 3.00
Oil Orange	lb.	1.90 — 2.10
Oil Scarlet	lb	2.00 — 2.50
Oil Yellow	lb.	1.80 — 2.50
Orange RG	lb.	2.00 — 2.25
Orange Y, conc	lb.	1.10 — 1.50
Ponceau	lb.	2.75 — 4.00
Quinoline Yellow	lb.	5.00 —11.00
Rhodamine	lb.	5.00 — 6.00
Saffranine	lb.	15.00 —20.00
Scarlet 2 R	lb.	3.00 — 3.25
Soluble Blue	lb.	15.00 —18.00
Sulfur Black	lb.	.75 — 1.00
Sulfur Black 150 p.c	lb.	— — 1.50
Sulfur Blue	lb.	2.60 — 3.25
Sulfur Blue-Black	lb.	3.00 — 4.00
Sulfur Brown	lb.	.50 — .60
Sulfur Green	lb.	2.00 — 3.00
Sulfur Yellow	lb.	2.00 — 2.75
Tartrazine	lb.	1.50 — 2.00
Wool Orange	lb.	2.25 — 3.25
Victoria Blue	lb.	17.00 —20.00
Victoria Blue, base	lb.	18.00 —21.00
Victoria Green	lb.	14.00 —16.00
Victoria Red	lb.	9.00 —12.50
Victoria Yellow	lb.	8.00 — 9.00
Yellow for wool	lb.	2.75 — 3.00

NATURAL DYESTUFFS.

Annatto, fine	lb.	.33 — .34
Seed	lb.	.11 — .14½
Carmine No. 40	lb.	4.25 — 4.75
Cochineal, Teneriffe, Silver	lb.	.95 — .98
Gray	lb.	.75 — .80
Indigo, Bengal	lb.	3.50 — 4.50
Oudes	lb.	3.00 — 3.25
Guatemala	lb.	3.00 — 3.10
Kurpahs	lb.	3.15 — 3.60
Madras	lb.	1.15 — 1.30
Madder, Dutch	lb.	.27 — .29
Nutgalls, blue Aleppo	lb.	— — —
Chinese	lb.	.25 — .26
Persian Berries	lb.	— — —
Turmeric, Madras	lb.	.09½— .10
Aleppey	lb.	.10 — .10½
Pubna	lb.	— — —
China	lb.	.07 — .07½

DYEWOODS AND RAW MATERIALS.

Algarobilla	ton	140.00 —150.00
Barwood	lb.	.06 — .08
Camwood, chips	lb.	.17 — .20
Divi-Divi	ton	68.50 —71.00
Fustic, sticks	ton	47.00 —48.00
Chips	lb.	.05½— .06
Hypernic chips	lb.	.09 — .10
Logwood, sticks	ton	39.00 —41.00
Chips	lb.	.03 — .03½
Myrobolans	ton	60.00 —65.00
Quercitron Bark No. 1	ton	28.00 —31.00
No. 2	ton	20.00 —25.00
Red Saunders, chips	lb.	.15 — .17
Sumac, Sicily, 27 p.c. tannin	ton	85.00 —87.00
Virginia, 20 p.c. tannin	ton	50.00 —59.00

EXTRACTS.

Archil, double	lb.	.15 — .17
Triple	lb.	.18 — .20
Concentrated	lb.	.21 — .26
Chestnut, 25 p.c. tannin	lb.	.02¼— .02¾
Clarified, 25 p.c tannin	lb.	.02½— .03
Cutch, Rangoon, boxes	lb.	.12 — .13
Liquid	lb.	.08¾— .09
Tablet	lb.	.10 — .12
Cubear, French	lb.	— — —
English	lb.	.18 — .24
Concentrated	lb.	— — .38
Flavine	lb.	1.00 — 1.50
Fustic	lb.	.13 — .16
Gall	lb.	— — .18
Gambier, 25 p.c. tannin	lb.	.10 — .10½
Common	lb.	.15⅛— .16½
Cubes, No. 1	lb.	.23 — .24
No. 2	lb.	.21 — .22½
Hematine	lb.	.09 — .10
Crystals	lb.	.24 — .34
Hypernic, liquid	lb.	— — —
Indigo, natural, for cotton	lb.	.50 — .54
For wool	lb.	.30 — .32
Indigotin, 100 p.c. pure	lb.	— — 5.50
Logwood, solid	lb.	.20 — .22
Crystals	lb.	.19 — .24
51° Tw.	lb.	.10 — .14
Myrabolans, 25 p.c. tannin	lb.	.06 — .07
Solid, 50 p.c. tannin	lb.	.10 — .11
Osage Orange—		
Powdered, Aurantine	lb.	— — .25
Paste	lb.	.06 — .12
Persian Berries	lb.	— — —
Quercitron	lb.	.07¼— .08¼
Sumac, liquid, 25 p.c. tan	lb.	.06 — .10½

DYEING ACCESSORIES.

Acetic acid, 28 p.c	lb.	.07 — .07½
56 p.c.	lb.	.15 — .15½
Glacial, 99 p.c	lb.	.37 — .40
Albumen, Egg	lb.	1.00 — 1.05
Blood, imported	lb.	.58 — .61
Domestic	lb.	.45 — .50
Alum, ammonium, lump	lb.	.04¼— .04¾
Alum, chrome	lb.	.18 — .19½
Alum, chrome potassium	lb.	.30 — .32
Alum, chrome sodium	lb.	.12 — .12½
Alum, potassium, lump	lb	.04½— .05
Aluminum acetate	lb.	.80 — .90
Aluminum chloride, liq	lb.	.04½— .05
Aluminum sulfate, techn	lb.	.02 — .02¼
Aluminum sulfate, iron free	lb.	.03¼— .03½
Ammonium vanadate	lb.	7.00 — —
Bleaching powder, 35 p.c	lb.	.02 — .02½
Borax, cryst.	lb.	.07¼— .07½
Citric acid, crystals	lb.	.72 — .75
Powdered	lb.	.72½— .75
Copper subacetate (verdigris)	lb.	.40 — .42
Copper sulfate (blue vitriol), 99 p.c.	lb.	.09 — .09¼
Dextrine, corn	100 lbs.	— — 5.90
Dextrine, imported potato	lb.	.13 — .14
Dextrine, domestic potato	lb.	.09 — .10
Ferric sulfate, basic (nitrate of iron), comm.	lb.	.02½— .03
True		.05 — .06
Ferrous sulfate (copperas)	100 lb.	1.00 — 1.50
Formic acid, 75 p.c	lb.	.35 — .40
Glauber's salt (sodium sulfate)	100 lb.	.70 — .75
Glucose	100 lb.	2.75 — 2.90
Glycerin, C. P.	lb.	.64 — .64½
Gum arabic, firsts	lb.	.50 — .54
Seconds	lb.	.43 — .46
Sorts, amber	lb.	.31 — .32
White	lb.	.43 — .46
Gum tragacanth, Alep., firsts	lb.	2.28 — 2.37
Seconds	lb.	1.94 — 2.00
Thirds	lb.	1.65 — 1.85
Sorts	lb.	.75 — .90
Hydrochloric acid (muriatic)		
18°	lb.	.01¾— —
20°	lb.	.01¾— .02
22°	lb.	.02¼— —
Lactic acid, 22°	lb.	.05½— .06½
44°	lb.	.14 — —
Nitric acid, 36°	lb.	.06½— .07
38°	lb.	.06¾— .07¼
40°	lb.	.07¾— .08
42°	lb.	.08½— .09½
Oxalic acid	lb.	.46 — .49
Potassium antimony tartrate (tartar emetic)	lb.	59 — .60
U. S. P.	lb.	.62 — .65
Potassium bicromate	lb.	.44 — .46
Potassium ferricyanide (red prussiate)	lb.	2.80 — 2.90
Potassium ferrocyanide (yellow prussiate)	lb.	1.20 — 1.25
Potassium tartrate, acid (cream of tartar)	lb.	.49½— .50
Prussian blue	lb.	.80 — .90
Soluble	lb.	.95 — 1.00
Sago flour	lb.	.04¾— .05
Soda ash, 58 p.c.	100 lbs.	3.50 — 4.10
Soda, caustic, 76-78 p.c.	100 lbs.	10.00 —10.50
Sodium acetate	lb.	.10½— .12
Sodium arsenate	lb.	.25 — .60
Sodium bichromate	lb.	.28¼— .28½
Sodium bisulfite	lb.	.05¾— .06
Sodium chlorate	lb.	.25 — .26
Sodium ferrocyanide (yellow prussiate)	lb.	.34 — .38
Sodium nitrite techn	lb.	.38 — .42
U. S. P.	lb.	.48 — .50
Sodium phosphate, com	lb.	.06 — .07
Sodium silicate, liquor 40° p.c.,	100 lbs.	1.05 — 1.25
Crystals	lb.	.02¼— .02½
Sodium sulfide, 60 p.c., fused	lb	.03 — .03¼
Crystals, 30 p.c.	lb.	.02 — .02¼
Sodium thiosulfate (hyposulfite)	100 lbs.	1.75 — 2.00
Soluble oil, 50 p.c.	lb.	.10 — .12
75-85 p.c.	lb.	.14 — 16
Stannous chloride (tin crystals)	lb.	.40 — .40½
Stannic chloride (tin bichloride), 50°	lb.	.19¾— .20¼
Starch, corn, pearl	100 lbs.	5.55 — 5.58
Potato	lb.	.13½— .14
Rice	lb.	.08— —.10
Wheat	lb.	.05 — .06
Sulfuric acid, 60°	ton	25.00 —27.00
66°	ton	34.60 —36.00
Oleum, 20 p.c.	ton	40.00 —45.00
Tartaric acid, crystals	lb.	.78½— .81
Turkey Red oil	lb.	.14 — .16
Zinc dust, 350 mesh	lb.	.18 — .25

IMPORTS AND EXPORTS OF COAL-TAR PRODUCTS AND NATURAL DYESTUFFS

The following is the Government report of imports and exports of these wares for the twelve months ending June, 1915, 1916, and 1917, and for the month of June, 1916, and 1917.

IMPORTS

ARTICLES	JUNE 1916		JUNE 1917		TWELVE MONTHS ENDING JUNE 1915		1916		1917	
Coal-tar products—										
Alizarin and alizarin dyes....lbs.	1,474	$3,004	2,120	$3,626	5,991,878	$1,586,099	17,580	$17,456	42,911	$75,775
Aniline salts....lbs.	......	......	......	......	897,990	130,793	16,084	3,978	......	......
Carbolic acid....lbs.	371,017	23,076	92,900	8,615	3,246,356	183,624	2,243,256	154,841	815,200	60,366
Colors or dyes....	......	337,096	......	288,238	......	5,851,887	......	3,340,592	......	3,161,371
Imported from—										
Germany....	......	......	......	1,449	......	4,241,681	......	849	......	464,499
Switzerland....	......	217,442	......	209,221	......	960,018	......	1,121,526	......	1,957,799
United Kingdom....	......	3,220	......	74,240	......	169,135	......	230,208	......	554,021
Other countries....	......	116,434	......	3,328	......	481,053	......	1,988,000	......	185,052
Dead or creosote oil....gals.	1,608,927	114,046	211,235	18,713	37,828,646	2,543,681	40,498,392	3,206,780	29,078,038	2,184,569
Indigo, synthetic....lbs.	......	......	241,817	168,909	......	......	......	......	1,036,634	689,037
All other ∫ free	......	87,222	......	37,633	......	272,164	......	523,006	......	660,376
⌡ dutiable	......	84,787	......	24,521	......	648,480	......	562,448	......	530,404
Gambier or terra japonica.... lbs., free	1,697,596	158,704	1,558,422	159,094	14,169,490	542,200	12,819,859	928,924	10,133,625	859,873
Indigo, natural and synthetic....lbs.	472,973	1,035,382	......	......	7,975,709	1,596,978	6,599,583	8,235,670	537,412	960,038
Natural....lbs.	......	......	227,993	477,724	......	......	......	......	1,238,693	2,459,835
Dyewoods, in a crude state—										
Logwood....long tons	36,262	1,167,634	3,189	70,235	55,059	742,234	134,629	3,437,698	122,794	4,137,400
All other....long tons	2,417	71,881	798	22,654	13,361	197,122	24,592	468,669	8,895	189,176
Total....tons	38,679	1,239,515	3,987	92,889	68,420	939,356	159,221	3,906,367	131,689	4,326,576
EXPORTS										
Dyes and dyestuffs....	......	782,646	......	1,461,646	......	1,177,925	......	5,102,002	......	11,710,887

THE AMERICAN MANUFACTURE OF LABORATORY APPARATUS

By F. W. Shulenberger.*

Though Less Spectacular, the Achievements of American Manufacturers of Laboratory Apparatus in Duplicating Articles of German and Austrian Make Have Been Equal to Those of the Chemists Themselves. Now, Declares the Writer, Where There is a Crying Need for Some Piece of Apparatus, a Way Is Usually Found to Procure It.

IT is a truism to state that the important work of the world is made possible by the possession of apparatus. This applies especially to factories and even to the farmer. It applies in particular to great communal undertakings such as the building of a railroad, the digging of a canal, or the waging of a war. One of the prominent political parties recommends in its plank the securing possession of the machinery of production.

These same conditions apply with special force to the chemical laboratory. As new demands are made on the chemist, new apparatus must be constructed to meet the requirements. The chemist is compelled sometimes to wait months, or even years, for a special piece of apparatus, without which a given test cannot be performed. In many laboratories, certain very important tests are not attempted because the financial backing is not at hand to purchase the expensive apparatus required. In some cases important apparatus cannot be obtained, even if funds are available, as, for example, at the present time, the polariscope. When it is remembered that the center of every up-to-date university is the chemical laboratory building, and the heart of every large manufacturing plant is its testing laboratory—not to mention the various private, municipal, or government research and control laboratories—the importance of the field of chemical laboratory apparatus will be to some extent appreciated. One prominent American research professor spent two years constructing the apparatus required for a special course. At the end of that time he was called away. The apparatus, however, remained for his successor, and is pointed out as one of the wonders of that university.

Germany and Austria Supplied the World.

It is claimed that the greatest single impetus to the commercial life of Germany, before the war, came through the manufacture of chemical laboratory apparatus. At that time, Germany and Austria had practically a monopoly of this business. This monopoly was fostered in a remarkable degree by the duty-free regulations of the United States and other countries. The duty-free orders went practically as a unit to these countries. The orders amounted to many millions annually. What was much more important, however, was the impetus which they brought to every branch of industry. The best apparatus was retained for home use. The latest discoveries from all countries were made at once applicable to this special field. There was at all times a corps of workers available who were familiar with the most up-to-date methods. The university graduates were placed at once where they could get that intimate practical training, for the want of which our university courses have been in many cases little more than a farce.

At the outbreak of the war, the United States, like other countries, was importing the better grades of chemical laboratory apparatus and chemical reagents almost wholly from Germany and Austria. Fortunately, there were in most cases large stocks on hand, and the British government permitted special shipments for a year or more after the outbreak of hostilities. Then all importations from Germany automatically ceased, except a few incidental shipments, as for example, what was brought by the Deutschland. On account of lack of materials and of workers, as well as of increased home demand, shipments from England, Sweden, Holland and France—the other countries which had previously furnished certain forms of laboratory appartus—diminished almost to the vanishing point. A notable exception in the case of England was quantitative filter paper, which was developed especially to meet the new unusual conditions. Large quantities of this English paper were shipped to America and it is now in regular use here. Japanese ware, particularly Japanese porcelain ware, also began to appear on the American market. It has come in increasing quantities ever since.

American Manufacturers Have Not Been Idle.

The most surprising development however, has taken place here in our own country. Factories of various kinds have sprung up as if by magic. One factory is producing chemical laboratory glassware, claimed to be better than any heretofore made abroad. Three or four others are producing glassware almost as good. Practically the same conditions apply to porcelain ware, though here the competition of the Japanese ware is a very serious factor. The number of glassblowing establishments, as well as the number of men employed, has increased very greatly. All the ordinary glass blown articles, as for example, condensers, tubes, bulbs, etc., are now made practically as required. The same applies to volumetric ware such as pipettes, burettes, flasks, cylinders, also hydrometers, picnometers, and thermometers. There is still difficulty in securing as rapidly as required special volumetric ware which is able to meet the requirements of the Bureau of Standards, and very accurate thermometers, such as the Beckman. Conditions are, however, improving continuously in this respect.

---

*Sales Manager, Apparatus Department, Eimer & Amend, New York.

Silica ware, formerly manufactured only abroad, is now made in this country. Alundum ware was originated here. Its scope has been greatly increased. Zirkite ware is just being introduced, and is recommended where very high temperatures are encountered. Palau ware, the new substitute for Platinum ware, seems to be equally satisfactory for most purposes, and costs only half as much. The output of domestic filter paper has been very greatly increased, and a number of new grades have already been put on the market. The glass factories are now turning out, almost as required, moulded ware such as jars, special bottles, and also more complicated forms such as gas generators, aspirator bottles, separatory funnels, etc. At first there was a great dearth of chemical reagents and dyes. This led to a very thorough investigation of our tremendous organic resources, consisting especially of coal and oil. The residues which had previously been disposed of largely in a practically crude condition, were now treated to obtain more refined products. At present most of the chemical reagents and dyes formerly made abroad are made in this country, and the movement seems to be just beginning. This development has been so rapid that in many cases where three years ago there were only swamps or other unused grounds, there are today row after row of factories and laboratories employing many chemists producing a great variety of chemicals and dyes.

Universities Can Do Much.

The universities seem to be duplicating a movement which took place in Germany many years ago. Then, in response to the needs of the times, there grew up around the leading university centers—more particularly Jena, Leipsic, Berlin and Vienna—a group of workshops, many of which developed into great factories sending their products to every part of the world.

The great Zeiss factory, for example, at Jena, originally inspired by the genius of Professor Abbe, developed later into a great cooperative community which seemed to have uttered the last word with reference to exactness of workmanship and detailed investigations extending into the most hidden recesses.

Under the stress of the world struggle and the needs of our country, American universities are establishing workshops and founding factories. There is probably not a prominent university in this country which is not producing or preparing to produce one or more articles for which there is an urgent demand and for which there is at present no other source of supply. In one or two cases formal action has already been taken by the Board of Regeants looking forward to the establishment of one or more factories in direct connection with the university. This movement is as yet only beginning.

Problems Confronting Our Apparatus Makers.

As previously indicated, there are some forms of apparatus which have not yet been satisfactorily duplicated in this country. Possibly first amongst these is the polariscope, almost indispensable for sugar control work. The main difficulty here is the lacks of suitable prisms. At the recent meeting of the American Chemical Society, the weakness of this country in the production of optical glass of all kinds was emphasized. However, several glass factories are now devoting special attention to this problem with every prospect of encouraging results. The conditions for polariscopes apply also to spectroscopes, though to a less extent. In the case of colorimeters, this optical difficulty seems to have been practically overcome. Agate mortars are not on the market at present. This is due partly to lack of suitable material, partly to lack of skilled workmen. Glass retorts have not yet been made in this country, at least to any extent, mainly because the demand is very limited. The supplies of platinum are very low. The government is endeavoring to retain the platinum for chemical uses, and is discouraging its use for jewelry or photographic purposes.

Among distinctive American contributions may be mentioned the following:—

Alundum, Zirkite and Palau ware, already alluded to. Especially important is a line of apparatus for the exact control of temperatures. This includes apparatus automatically controlled, electrically heated for temperatures from Zero to 40° centrigrade, similar apparatus for temperatures to 70°C, also to 180°C, also to 260°C. It also include furnaces for temperatures up to 1000°C and 2000°C or over, along with exact control through pyrometers and rheostats. It includes also, at the same time, an exact control of gaseous pressure from practically absolute vacuum up to many atmospheres along the gauges and pumps of various kinds for controlling the pressure. The condition of humidity is similarly controlled. There are also stirrers operating at exact speed, etc. In general, the tendency is to standardize every possible external condition.

In line with this general tendency may be mentioned special apparatus intended to add hydrogen or some other gas to an existing molecule, thus radically changing the material, also apparatus intended to remove hydrogen or some other gas from an existing molecule, thus again radically changing the material. By the first process, expensive oils, etc., are built up from cheaper grades. By the second process, crude natural gas, for example, is transformed to benzole, which is the basis of so many products.

Even more important and significant is the work which is being done in connection with colloids. The field is there very large; the operations involved are diverse, and the apparatus required is in many cases complicated. The early work in this field was done mainly abroad, much of it in connection with the ultra microscope. This modification of the microscope has not yet been put on the market from an American factory but probably will be in the near future. Other apparatus of value in testing colloids is a special viscosimeter, special electro analysis apparatus, etc. A line of new apparatus is just now being prepared to show crystallization, distillation, and evaporation in connection with colloids. The constant temperature and constant pressure apparatus is also of great importance in this connection.

It will probably have become clear that as new discoveries are made new apparatus is required. Usually the discovery and the invention of the apparatus go hand in hand; afterwards the apparatus is in many cases made more perfect. At present, owing to the tremendous exertions of American chemists and inventors, the difficult situation is fairly well cared for. Prices are high, but home production tends to increase so that normally prices would go down. The grade is being continually improved and where there is a crying need for some piece of apparatus a way is usually found to procure it.

NEW PUBLICATIONS OF THE BUREAU OF MINES.

(List 50.)

Coal-mine fatalities in the United States, 1916, compiled by A. H. Fay. 1917. 42 pp.

BULLETINS.

Bulletin 119. Analyses of coals purchased by the Government during the fiscal years 1908-1915, by G. S. Pope. 1916. 118 pp.

Bulletin 143. Abstracts of current decisions on mines and mining reported from May to August, 1916, by J. W. Thompson. 1917. 72 pp.

TECHNICAL PAPERS.

Technical Paper 87. Methods of testing natural gas for gasoline content, by G. A. Burrell and G. W. Jones. 1916. 26 pp., 7 figs.

Technical Paper 106. Asphyxiation from blast-furnace gas, by F. H. Willcox. 1916. 69 pp., 8 pls., 11 figs.

Technical Paper 165. Quarry accidents in the United States during the calendar year 1915, compiled by A. H. Fay. 1917. 77 pp., 1 pl.

Technical Paper 168. Metal-mine accidents in the United States during the calendar year 1915, compiled by A. H. Fay. 1917. 114 pp., 2 figs.

(List 51.)

BULLETIN.

Bulletin 124. Sandstone quarrying in the United States, by Oliver Bowles. 1917. 143 pp., 6 pls., 19 figs.

TECHNICAL PAPERS.

Technical Paper 82. Oxygen mine-rescue apparatus and physiological effects on users, by Yandell Henderson and James W. Paul. 1917. 106 pp., 5 pls., 6 figs.

Technical Paper 135. Bibliography of recent literature on flotation of ores, January to June, 1916, compiled by D. A. Lyon, O. C. Ralston, F. B. Laney, and R. S. Lewis. 1917. 20 pp.

Technical Paper 140. The primary volatile products of the carbonization of coal, by G. B. Taylor and H. C. Porter. 1916. 59 pp., 1 pl., 25 figs.

Technical Paper 143. The ores of copper, lead, gold, and silver, by C. H. Fulton. 1916. 45 pp.

Technical Paper 160. The determination of nitrogen in substances used in explosives, by W. C. Cope and G. B. Taylor. 1917. 46 pp., 1 pl., 4 figs.

Technical Paper 166. Motor gasoline; properties, laboratory tests, and practical specifications, by E. W. Dean. 1917. 27 pp.

Note.---Only a limited supply of these publications is available for free distribution, and applicants are asked to co-operate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers can not be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

Ultra Violet Light

By Carleton Ellis and A. A. Wells.

The publishers of the Chemical Engineer regret to announce that owing to an accident the manuscript of Part VII of the article, "Ultra Violet Light: Its Application in Chemical Arts," by Carleton Ellis and A. A. Wells, was not available for publication in this issue. The installment referred to continues the discussion of the sterilization of liquids by means of ultra violet rays. To readers who have been following this article every month are offered apologies and the assurance that it will make its appearance in the October issue.—Ed.

Swiss Manufacture of Coal-Tar Products.

The manufacture of coal-tar dyes and medicinals in Switzerland is confined chiefly to the city of Basel. The four large companies in that city engaged in this branch report profits far in excess of any sums hitherto recorded. Thus the well-known Sandoz Color Works paid at the close of 1916 dividends of 25 per cent. and in addition a bonus of $200 per share. This was after granting a bonus of $80,000 to the working staff and setting aside ample sums for various funds.

These conditions are causing alarm in German manufacturing circles, especially when taken in connection with the existing embargo on the exportation of nearly all chemical and pharmaceutical products from the Empire. A German trade journal expresses openly the fear that "the world's markets have found new sources of chemical products, and will learn to do without those of German origin if exportation is not made easier as quick as possible."

THE CHEMICAL ENGINEER

VOL. XXV. SEPTEMBER 1917 No. 7

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, SEPTEMBER, 1917

Coal-Tar Chemistry 241
Edited by Thomas H. Norton, Ph.D., Sc.D.
Under which is included:

EDITORIALS:

The Purity and Strength of American Artificial Colors 241
Death of Adolph von Baeyer 242
Co-Operation in Research 243
Artificial Phenol 244
Women and Dyestuffs 244
Swift Expansion of the American Manufacture of Coal-Tar Colors 245
The Swiss Color Industry 245
The Reliability of American Colors 246
The New Location of the National Aniline and Chemical Co. 246

COAL-TAR CRUDES:

The Manufacture of Anthracene 247
Some Sources of Benzene and Toluene for High Explosives 249
T. F. E. Rhead.
The Recovery of Toluene from Illuminating Gas 250
The German Coal-tar and Explosive Industries 254
Estimation of Benzol in Gas 254
Coal-tar Crudes in Australia 254
The British Supply of Coal Tar 254

COAL-TAR INTERMEDIATES:

Sulfonating Kettles 254
Explosions of Picric Acid 257
T. Sington.
Conflagrations in Coal-Tar Chemical Plants 258
Manufacture of Benzene Sulfonic Acid 258
A New and Sensitive Indicator 258

ARTIFICIAL COLORS:

A Series of New Ortho-Oxy-Azo Dyestuffs Containing Copper 259
Growth of the American Dyestuff Industry. 260
Standards of Dye Strength in England 263
The Dyeing of the New Standard Khaki in England 264
C. M. Whittaker, B.Sc.
The Bayer & Co. Works at Rensselaer 265
Colors for Army Uniforms 265
The Combination of Leading German Manufacturers of Artificial Colors 266
Reserve Stocks of Artificial Dyes in China .. 267

NATURAL DYES:

The Manufacture of Archil Extract in the United States 268
Views of Archil Industry at Magdalena Bay 269
Autumnal Foliage as a Source of Dye 270

SYNTHETIC DRUGS AND PERFUMES; PHOTOGRAPHIC DEVELOPERS:

Salvarsan of Domestic Make 271
Antipyretic Stimulants 272
Increased Cost of Perfumery 272
New Arseno-Phosphorus Compounds 272

MISCELLANEOUS:

Manufacture of Benzyl Chloride 272
Theft of Dye Formulas 273
New Benzol Plant 273

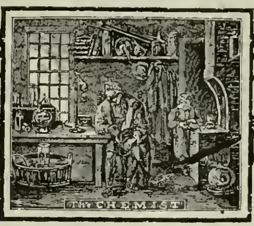
CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS:

Crudes, Intermediates and Explosives, Synthetic, Medicinals, Flavors and Perfumes, Photographic Developers, Artificial Colors 273
Natural Dyestuffs, Dyewoods and Raw Materials, Extracts, Dyeing Accessories 274
Imports and Exports of Coal-tar Products and Natural Dyestuffs 274
The American Manufacture of Laboratory Apparatus 275
F. W. Shulenberger.
Ultra Violet Light: Its Application in Chemical Arts 277
Carleton Ellis and A. A. Wells.
Table of Contents 278
Chemical Investigation, Efficiency and Control 279
Conducted by Charles B. Davis.
Foreign Trade Opportunities 280
Distillates: News Notes of Chemical and Allied Industries 280

FOR SALE—Vacuum Dryer; one-ton capacity, made by J P Devine & Co. Apply to E. F. Houghton & Co., Purchasing Department, 340 W. Somerset St., Philadelphia. Can be seen at same address.

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.



ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

P. A.—I note from the official letter you have just received from the patent office and which you have forwarded me that the first and third claims have been erased in accordance with my advice to you in the May issue. I am sending you by mail the full amendment to the patent, including three new claims. If these new claims are allowed, which I believe they will be, since they do not infringe any of the patent citations, I would strongly recommend that the patent be allowed to go to issue without further changes. The claims, as now drawn, fully cover the subject matter contained in the specification.

H. S. W.—The sample of oil from the insurance company was received on the fifteenth of last month. I find that when this oil is incorporated with wool it rapidly heats up in the manner complained of. On chemical analysis this oil is shown to consist of fatty acids and has a decidedly fishy odor. Its fish origin is further confirmed by the yield of insoluble bromides, which bromides, instead of melting to a clear liquid at 176 C gradually blackened and decomposed showing that the Hexabromides are not of linseed oil origin.

My full report with opinion and recommendations will be forwarded to the company by the end of this month.

A. A. T.—The French patent covering a process for producing "Motor Spirit for Internal Combustion Motor Engines" is carried out in the following manner:

The fraction of kerosene oil boiling up to about 220°C, which must be practically free from petroleum spirit, is forced through very narrow interstices at high pressure; the resulting product burns more rapidly than kerosene oil.

After you have concluded your experiments I shall call and take samples at different stages of your process and submit them to official burning tests in order to ascertain whether your product is superior to that of the French process and then render my report to the persons you mentioned.

T. W. L. I find on analysis that the dyestuff contained in your wool sample was produced by the following method:

5.0 grams of hydrochloric acid (sp. grf. 1.143.
5.0 grams of analin.
1.0 grams of p-nitranilin.
2.0 grams of nitrobenzene.
0.03 grams of ammonium molybdate.

Boil these ingredients together and raise the temperature to 220C, when the mass will form a paste. Now dissolve this paste in hot water and precipitate the dye by the addition of soda. In dyeing with this, an acetic acid bath is used.

E. S. E. From the chemical analysis of the artificial stone you forwarded this month, the working formula for its reproduction is as follows:

The materials are crushed and ground and 4.0 per cent. binding material in the form of quartz is added. Now incorporate sufficient water to form a stiff paste and press hydraulically into your desired shapes and burn in the electric furnace.

W. T. Your desire for a process of canning requiring no heating or pasteurization and producing products free from antiseptics is being looked into. I understand also that no sugar is to be used. The fee charged for this class of work will be commensurate with the time consumed in the investigation. I have not the slightest doubt that such a process can be devised.

Charles B. Davis.

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail ar specifically requested, communications can only be considered in the order of their receipt.—Editor.

FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Celluloid Articles.

25053.—A man in France desires to purchase, or to secure an agency for celluloid articles of all kinds, linen, silk, and cotton hosiery. He will guarantee in advance large purchases of goods each year. Correspondence should be in French. Reference.

Formaldehyde, Tannic Acids, Etc.

24800—A firm in England wishes to buy cream of tartar substitutes, formaldehyde, pharmaceutical products, tannic acids, etc. Samples and complete analysis should be submitted. Payment will be made by cash against documents through New York bankers. Quotations should be made c. i. f. or f. o. b. any port. References.

Carbon Balls.

24332—A firm in New Zealand is in the market for carbon balls. Quotations should be made f. o. b. American port. Payment will be made through a branch office in London. Correspondence may be in English. Reference.

Chemical Products.

24826—A company in Italy wishes to buy starch, dextrine, resin, chemical products, etc. A complete list of the commodities desired may be had on application of the Bureau or its district offices. Reference.

Paints, Oils and Explosives.

25020.—A man in Bolivia who has been very successful as a general importer and exporter, wishes to secure agencies for sheet steel, corrugated and flat, galvanized, etc., wire nails, steel rails and structural steel, window and plate glass, flour, lumber, canned salmon and other canned foods, Siam and India rice, cement, paints and oils, and explosives. He prefers to deal direct with manufacturers.

DISTILLATES

News Notes of Chemical and Allied Industries

Chemicals.

The M. B. Manufacturing Corporation, Manhattan, has been incorporated under the laws of New York to manufacture and deal in chemicals, by N. Lazarus, A. Phillippe and A. Romero, 5,000 Broadway, with 100 shares of preferred stock at $100 each and an active capital of $5,500.

Chemicals and Drugs.

The Lippincott Chemical Co., Inc., Manhattan, has been incorporated under the laws of New York with a capital of $25,000 to deal in chemicals and drugs, by W. A. Lippincott, B. Berkow and J. F. Russell, Jr., 43 Cedar street, New York City.

Chemical Compounds and Dyestuffs.

With an active capital of $5,000 and 1,000 shares of common stock, no par value, the Clement Synthetic Gas & Chemical Company, Inc., Manhattan, has been incorporated under the laws of New York to deal in chemical compounds, dyestuffs, airplanes and automobiles. L. Clement, R. T. Grogan and H. Boes, 119 East 88th street, New York City, are the incorporators.

Nitrogen Fixation Corporation.

With a capital of $1,000,000, the Nitrogen Fixation Corporation, Manhattan, has been incorporated under the laws of New York, to manufacture cyanogen compounds and carry on a general chemical business. The incorporators are J. F. A. Comstedt, J. R. Rubin and S. M. Weil, 34 Pine street, New York City.

Analytical and Consulting Chemists.

Ossa Sowers, Inc., analytical and consulting chemists, has been incorporated under the laws of New York to operate laboratories in Manhattan with a capital of $5,000. The incorporators are J. P. Ross, J. Jacobson and O. Sowers, 9 East 9th street, New York City.

Drugs and Chemicals.

Brooklyn Standard Laboratory, Brooklyn, N. Y., has been incorporated under the laws of that state to manufacture chemicals, drugs, supplies and general merchandise. The capital is $10,000 and the incorporators are P. W. Schumacher, P. F. Lahm and L. Schopfer, 213 Cornelia street, Brooklyn.

THE CHEMICAL ENGINEER

VOL. XXV. OCTOBER 1917 No. 8

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

Statement of the Ownership, Management, etc., Required by the Act of Congress of August 24, 1912,

Of the Chemical Engineer, published monthly at New York, N. Y., for October 1st, 1917.

County of New York, State of New York, ss.

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Robert H. McCready, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Chemical Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, McCready Publishing Co., 118 East 28th St., N. Y.; editors, Thos. H. Norton, 118 East 28th St., N. Y.; L. T. Clark, 118 East 28th St., N. Y.; managing editor, none; business manager, R. H. McCready, 118 East 28th St., N. Y.

2. That the owners are: C. J. O'Brien, 22 North William St., N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him. ROBERT H. McCREADY.

Sworn to and subscribed before me this 21st day of September, 1917.
FREDERICK PFISTER.
(My commission expires March 30, 1919.)

CONTENTS, OCTOBER, 1917

The Significance of the National Exposition of Chemical Industries 282
Thomas H. Norton, Ph.D., Sc.D.

Coal-Tar Chemistry Section 296
Edited by Thomas H. Norton, Ph.D., Sc.D.

Under which is included:

ARTIFICIAL COLORS.

The Discovery of Primuline.... 296
Arthur G. Green.

Manufacture of Copper Compounds of Ortho-Oxy-Azo Dyestuffs 298

New Azo Dyes from Chromotropic Acid...... 298

New Class of Dyes from Patent Blue........ 299

NATURAL DYES:

Development of the Natural Indigo Industry in India 300
Prof. H. E. Armstrong.

Algarrobin 301

The Coloring Material of Rice Leaves........ 302

The Use of Bacteria in the Preparation of Natural Indigo 302

A Foaming Process for Treating Textiles.... 303

Dye Extract Works in Jamaica............. 303

Dyeing by Means of Nitrous Acid and Metallic Salts 303

Divi-Divi Extract 303

Apparatus for Dyeing 303

Increased Cultivation of Indigo in Central America 304

Natural Colors, References to Articles...... 304

Toxicity of Carotin 304

MISCELLANEOUS:

Outlook for the British Chemical Industry.... 304
Prof. H. E. Armstrong.

Progress of the Coal-Tar Chemical Industry in Canada 304

Improved Method of Making Sodium Phenate. 307

WHOLESALE PRICES OF COAL-TAR PRODUCTS:

Crudes, Intermediates and Explosives; Synthetic Medicinals, Flavors and Perfumes; Photographic Developers, Artificial Colors.. 308

Natural Dyestuffs, Dyewoods and Raw Materials, Extracts, Dyeing Accessories........ 309

Imports and Exports of Coal-Tar Products and Natural Dyestuffs 309

Chemical Investigation, Efficiency and Control... 310
Conducted by Charles B. Davis, F.C.S.

Ultra Violet Light: Its Application in Chemical Arts. Part VII....................... 311
Carleton Ellis and A. A. Wells.

Title Page and Index to Chemical Engineer, Volume XXV. 317

War Profits of Chemical Corporations.

In the taxation of the extra "war profits" earned by American industrial corporations, it is quite evident that chemical companies, and especially those closely connected with the manufacture of coal-tar products, will contribute a leading share. The following table shows the net earnings, for the past three years, of the leading companies in this category:

Companies.	1916.	1915.	1914.
Atlas Powder Co....	$2,639,790	$1,671,762	$294,150
Barret Co...........	4,247,858	2,482,236	1,280,476
du Pont de Nemours	82,013,020	57,257,308	4,831,793
General Chemical Co.	12,286,826	5,958,746	2,857,898
Grasselli Chemical Co.	6,760,669	4,859,000	1,080,000
Hercules Powder Co.	16,688,873	4,886,102	1,247,255

THE SIGNIFICANCE OF THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

By Thomas H. Norton, Ph. D., Sc. D.

Wholly Apart from Its Appeal to the Eye, but of Vastly Greater Importance, Was the Undercurrent of Intense Seriousness which Sooner or Later Inevitably Forced Itself Upon Visitors to the National Exposition of Chemical Industries Held in New York. In the Following Analysis of the Event, the Writer Interprets Its Psychological as Well as Its Commercial Significance, and Also Gives a Thorough Review of the Exhibits and Addresses.

The Third National Exposition of Our Country's Chemical Industries, held on the week beginning September 24, at the Grand Central Palace in New York City, was, in every way, a notable event.

The first exposition, in September, 1915, was largely tentative, but proved to be a distinct success. When its successor was held in 1916 the number of exhibits was doubled and the attendance largely increased.

In 1917, despite the fact that we are fairly embarked upon a war, prospectively the greatest in our national history, the exposition proved to be a pronounced advance upon that of the preceding year. The exhibitors numbered 325 and the space occupied was triple that of 1915, three floors of the vast building being covered by their displays.

The number of admissions was over 100,000. It was estimated that about 25,000 chemists, consumers of chemicals, producers of chemicals and manufacturers of the accessories required by the latter were brought together during the exposition.

It was eminently educative, although practical business purposes were the chief incentive in the case of most exhibitors. As a rule what they displayed in their booths was so arranged and labeled or explained by competent attendants that the layman could easily grasp the economic importance of the wares shown. Their origin, their relation to one another, their uses were all brought out clearly and in most instances attractively and tastefully.

There was, however, an almost complete absence of the spectacular. An undertone of great seriousness was evident. Not only the topics of conversation among the throngs in attendance, but the character of the exhibits, and the dominating note in the various addresses and lectures all revealed a consciousness that we have entered upon an historic epoch destined to test to the uttermost the entire fabric of American chemistry as well as American ingenuity, adaptation and inventive skill.

There was an inspiring conviction that the chemists of our nation are fully competent to deal with the manifold problems accompanying this greatest of the world's wars, in which we are now about to play a leading part, possibly the decisive rôle. It is pre-eminently a war of engineers and chemists. Can American chemists show themselves fully equal to the chemists of Europe in evolving methods of offense and means of defense?

The booths of the exposition contained the answer. They revealed to the eye the wonderful accomplishments of the past three years. They showed how swiftly and how effectively it has been possible to create on American soil the manufacture of a multitude of products, for which a few months ago we were entirely dependent upon European sources. The eye rested frequently upon the imposing mechanical appliances requisite for the life of new-born chemical industries.

Leaders of American chemistry portrayed eloquently how we have become a giant purveyor of powerful explosives; how we are dealing with a multitude of problems intimately associated with war in the air and beneath the ocean's waves as well as in the trenches.

The intelligent and patriotic citizen could not leave the halls of the exposition without the profound convicition that our chemists form a first line of national defense, that without their wholehearted, far-reaching co-operation the power of the legions we send across the Atlantic would be sadly crippled.

In analyzing the exposition more in detail there was general recognition of the leading rôle played by the coal-tar chemical industry. Its products were shown in abundance, upon every hand. They lend themselves admirably to effective displays for the eye, and they revealed in a concrete form the marvelous creation during a few months of what will constitute permanent factors in our economic structure.

Next in interest came the varied mechanical devices provided for the chemist to accomplish his wonders. There is little doubt but that the confidence and assurance felt by our chemists in facing the numerous problems of today and of the morrow, is vastly reinforced by the realization of the equal ability of our engineers to furnish the most varied equipment for their needs.

Closely associated in this connection was the evidence of the success recently following American enterprise in making from American materials the many diverse articles in glass and porcelain needed constantly by the chemist, but obtainable hitherto only from Germany. In this category falls also the fine quality of optical glass now made in the United States.

All in all the exposition was thoroughly worthy of the nation's swiftly expanding industry, in which so many millions have been invested these past three years. It was eminently satisfactory to the economist, revealing the degree to which we are emancipating ourselves from foreign dependence. Finally it was inspiring to the intelligent and patriotic citizen, outlining clearly one of the potent factors for success in the war before us.

THE EXHIBITS.

It is impossible to present more than a very cursory mention of the many exhibits of distinct value to those interested in coal-tar chemistry.

To a certain extent something of value, something suggestive and helpful might be found in nearly every display. This was especially true of the many exhibits of machinery and other accessories required in chemical plants.

It seems, however, desirable to group together those exhibits which revealed in a very striking manner the present status of coal-tar chemistry in the arts, and the tremendous advance made during the past two or three years. Enough detail is furnished in connection with the name of each company exhibiting to give a fair idea of the extent and variety of its operations. The list includes all exhibitors engaged in the production of coal-tar crudes, in the refining of the crude products, in the transformation of such crudes into intermediates and in the manufacture from such intermediates of finished dyestuffs, medicinals and other allied substances. It includes further the exhibits of natural dyes and of the leading firms supplying the special mechanical equipment of the plants devoted to coal-tar chemicals.

In their entirety these exhibits formed the most striking feature of the exposition and attracted general attention.

The Barrett Co., New York.

The exhibit of this company was one of the most attractive and instructive in the whole exposition, showing the great range and variety of the current commercial products isolated from coal-tar. The list of these crude and refined substances is given in full in order to convey an adequate idea of the extent to which differentiation has been carried in the primary stage of the coal-tar chemical industry for the purpose of meeting a multitude of well-defined economic needs: Benzol, pure; benzol, 100%; benzol, 90%; benzol, 50%; benzol, straw color; toluol, pure; toluol, commercial; toluol, straw color; xylol, pure; xylol, commercial; solvent naphtha; crude solvent naphtha; hi-flash naphtha; crude heavy solvent naphtha; No. 10 naphtha; heavy naphtha; pyridine, denaturing; pyridine, commercial; heavy solvent oil; shingle stain oil; special heavy oil; special heavy oil, grade 2; neutral hydrocarbon oil; creosote oil; crude carbolic acid, in 8 grades; dip oil; phenol, U.S.P., natural; phenol, U.S.P., synthetic; cresol, U.S.P.; refined cresylic aid, No. 5; ortho-cresol; para-cresol; meta-cresol; xylenols; naphthalene, flake, small balls, large balls, crushed, powdered, granulated, rice, lump, one-ounce cakes, square tablets and round tablets; cryst alba; anthracene (crude) 25%; anthracene 40%; anthracene, 80%; carbazole; phenanthrene; pyxol; tarola X; special cresol compound; disinfecting powder; disinfectants, coefficients 2 to 20.

Quite recently the company has taken up the manufacture of various intermediates and medicinal compounds. The exhibits in this field were:

Paracumaron resin; para-amido-phenol; nitro-naphthalene; alpha-naphthylamine; resorcin, technical; resorcinol, U.S.P.; salicylic acid, U.S.P.; sodium salicylate, U.S.P.; methyl salicylate, U.S.P.; salol, U.S.P.; salicylimide.

In the 30 different plants of the company over 200 distinct chemical products are now currently manufactured. Great quantities of benzene and toluene are furnished under contract to the Allied governments to use in making munitions.

The Barrett Company has been the chief organization in this country to perfect the methods of separating the different constituents of coal-tar, and to popularize the use of the varied products in almost numberless directions. It is to the efforts of this company, extending back for years, that our synthetic chemists found it possible since 1914 to secure promptly large amounts of coal-tar crudes, refined to the requisite state of purity, as they laid the foundations for an American dyestuff industry, and for the production of numerous medicinals. Synthetic phenol was made by the Barrett Company some 10 years ago, although no effort was then attempted to place it regularly upon the market.

An impressive feature of the exhibit was a large wall chart showing the genealogical derivation of the leading products resulting from the destructive distillation of coal. Samples of these products, in vials of uniform size, accompanied the various names on the chart, which numbered slightly over 200. The realistic diagram is of pronounced educational value, and could most helpfully be employed in every school of science specializing in coal-tar chemistry.

The American Coal and By-Products Coke Co., Chicago.

This company had an interesting exhibit of the plans and materials used in the construction of the Roberts flueless coke oven. The importance of this oven, as permitting a vastly enlarged utilization of numerous deposits of bituminous coal, hitherto regarded as valueless for coking purposes, has attracted widespread attention. As the only by-product coke oven of purely American origin it promises to solve urgent problems connected with the satisfactory and economic distillation of many forms of soft coal, now untouched for this purpose, and also of the enormous deposits of lignite in our Western States. The company displayed a tasteful array of coal-tar crudes and their derivatives coming from the plant at Canal Dover, O.

The H. Koppers Co., Pittsburgh, Pa.

An instructive exhibit was made of the details of construction of the coke ovens installed by this company at various points, and contributing largely to our current supply of coal-tar crudes. The immediate products of coking were shown in a well arranged set of samples.

The United Gas Improvement Co., Philadelphia.

An extensive series of refined coal-tar crudes was shown by this company, which manufactures on a large scale all of the products obtained directly from tar. The pure compounds included benzene, toluene, xylene and naphthalene. The manufacture from the latter of phthalic anhydride has recently been installed and a daily production of 200 lbs. has been attained. Other exhibits were crude phenol, solvent naphthas, heavy naphthas, dead oil, creosote oil, paving and roofing pitches, road compounds, etc.

The Semet-Solvay Co., Syracuse, N. Y.

One of the most attractive features of the exposition was the finely arranged display of the company's products obtained from coal-tar. These included the hydrocarbons and the high explosives picric acid and trinitro-toluene derived from them; phenol and such derivatives as salicylic acid, methyl salicylate, acetylsalicylic acid, etc. The relationship of the various compounds to coal was shown on several tables holding sample bottles with arrows indicating the different changes as the result of chemical change. The whole exhibit was unusually instructive, and illustrated the growing tendency among manufacturers to present the basic facts in their processes so clearly and simply that they may easily be grasped by the non-scientific mind.

This organization has contributed much to the rapid expansion of the coal-tar chemical industry by its intelligent handling of the crude material controlled by it in large amounts in connection with the establishment of Semet-Solvay by-product coke ovens. The company now operates twenty-one plants under its system and claims to be the largest individual producer in the world of coal distillation products. It has not attempted to manufacture a great variety of compounds, but a limited number have been produced upon a very extensixe scale. Sulfur black is the only dyestuff which the company has manufactured.

The National Aniline & Chemical Co., Inc., New York.

The exhibit of this company attracted general attention from the fact that it is the largest single factor in the American coal tar color industry. It represents a consolidation of various interests, producers of coal-tar crudes, of intermediates, of synthetic colors, and of the chemicals required in the various stages of manufacture, which will enable it to develop along numerous special lines at a minimum of cost of production. A few months ago it was organized by the merging together of the following companies: Schoellkopf Aniline & Chemical Works, Inc., Buffalo; W. Beckers Aniline & Chemical Works, Inc., Brooklyn; National Aniline & Chemical Co., New York; Benzol Products Co., Marcus Hook, Pa.; Standard Aniline Products, Inc., Wappingers' Falls, N. Y.; and also certain plants and properties of the General Chemical Co., the Barrett Co. and the Semet-Solvay Co.

The extensive exhibit included a number of different categories and covered nearly the whole range of coal-tar products. They are given in detail, as illustrating in a striking degree the wide diversity of output of our leading producer of artificial dyes and its lack of dependence upon outside sources for the materials employed.

Coal-tar chemicals, used in textile or other industries: Aniline oil, aniline salt, beta-naphthol, cresol, phenol, diphenylamine, dimethyl-aniline, hydroquinone, meta-phenylene diamine, meta-toluylene diamine, naphthalene, nitro-benzene, paranitraniline, paramidophenol, para-phenylene diamine, phenol, phenyl ethyl alcohol, resorcin, sodium benzoate, thiocarbaniline, thiocarbtoluide, thiocarbxylide, benzaldehyde, benzyl acetate, benzyl benzoate, benzoic acid.

Intermediates, used chiefly in making synthetic dyes: Amido-salicylic acid, benzidine, chromotropic acid, dinitro-benzene, dinitro-toluene, G salt, H acid, Koch acid, metanilic acid, N W acid, naphthol1sulphonic acid (1:5), ortho-toluidine, phenyl-hydrazine-sulphonic acid, paramido-acetanilide, phenyl acid, picramic acid, pseudo-cumidine, R salt, sulphanilic acid, Schaeffer salt, xylidine.

Direct aniline colors, for cotton, union goods, etc.: Erie black GXOO, Niagara blue 2B, Niagara dark blue 3R, Niagara blue D B, ammaco direct blue 3B, Erie brown C, Erie brown G R, direct brown T, Erie green W T, ammaco direct green W B, Erie green M T, Erie orange 2R, benzo purpurine 4B W, Congo red 4B, Niagara garnet R, ammaco primuline W B, Niagara violet B W, Niagara fast yellow F, Niagara yellow K M, ammaco chloramine yellow W B, ammaco delta red 2B.

Sulphur colors, for cotton, fast to washing, cross-dyeing, etc.: Sulphur black F conc paste, sulphur black sap powder, sulphur blue paste, sulphur blue sap, sulphur direct navy blue, sulphur brown 2G, sulphur brown sap, sulphur brown W F, sulphur brown LY conc, sulphur green sap, sulphur yellow B W, sulphur khaki, all shades.

Acid colors, for wool, silk, leather, lake making, etc.: Buffalo black N B R, Buffalo black 10B, Buffalo black 8B, Buffalo black 3G, Buffalo black R B, ammaco acid black T R, Buffalo black A K, acid black 4 A B, Buffalo fast blue R, Buffalo cyanone 3R, induline, resorcine brown, fast brown, ammaco acid green

L, orange A conc, orange S conc, orange 2G crystals, brilliant scarlet 3R, xylidine scarlet, fast red S conc, scarlet B R, azo rubine extra, Buffalo fast crimson R, azo Bordeaux, Buffalo fast fuchsine D, Buffalo fast fuchsine G, Buffalo fast fuchsine R, Buffalo fast fuchsine 6B, wool red 40F, cloth red G, cloth red R, croceine scarlet moo, lanacyl violet M, acid violet, Buffalo violet 4B, Buffalo fast violet B, wool yellow ex conc, azo yellow A 5W, metanil yellow 1955.

Basic colors, for leather, paper, lake making, cotton printing, etc.: Brush blacks, methylene blue B S conc, ammaco basic navy blue D A conc, Bismarck brown Y ex, Bismarck brown 53, ammaco Victoria green W B, chrysoidine Y ex, chrysoidine 3R, safranine A, ammaco safranine B L, methyl violet.

Chrome colors, for wool, fast to light, fulling, etc.: Buffalo chrome black 2B N, ammaco chrome black B N, alizarol black 3G, alizarine blue G, alizarine dark blue G N, alizarine dark blue R B N, alizarine bright blue 3R Y N, serichrome blue R, alizarol brown B, alizarol brown R B, serichrome green B, Buffalo chrome green C B, ammaco alizarine orange W B, ammaco alizarine yellow 331, alizarol yellow 3G.

Certified colors, for food products, confectionery, etc.: Amaranth 107, ponceau 3R 56, orange I 85, tartrazine 94, sodium indigo disulphonate 692, Ceylon red, Sultan red, Burmah red, Coralline red, Rajah red, raspberry red, strawberry red, Brazil brown, Caracas brown, Maracaibo brown, deep chocolate, yellow color, egg shade; Tokio orange, Tangier orange.

Miscellaneous colors, Nigrosines, water and spirit soluble: Oil black, chrysoidine base, Victoria green base, oil colors, fur black, fur brown.

Most of the colors were accompanied by handsome specimens of their use on different textiles, leather, etc.

The company has branch agencies in twelve cities and is steadily increasing the number of its tinctorial products. It is in an admirable position to present a bold face to foreign competition when the time arrives in the early future.

It is not easy for the layman, or even for the average chemist, to realize adequately the full extent to which our textile and many allied industries are indebted to the above organization and its component parts for diminishing by wonderful energy and skillful utilization of available materials the pinch of our dyestuff famine.

The Central Dyestuff & Chemical Co., Newark, N. J.

This company has been an important factor in laying the foundation of the American artificial color industry, its origin dating back to 1898. It has specialized in azo dyes and its products have been of great value in meeting the pressing demands of the past three years. The current output was displayed in a most attractive manner and included the following colors: Fast red, orange G and Y, erythrine, benzopurpurine B, naphthol blue, scarlet 2R, methyl violet 3B, chrysoidine X, diamine blue 2B, azo rubine, claret red R B, Bismarck brown R and Y, amaranth, chrome black, fast acid red 6B G, amido black B, wool orange G, wool scarlet 4R, Bordeaux, lake violet, lake scarlet, lake brown, lake orange, roccelline, methylene blue, wool claret, induline, various nigrosines and numerous oil colors. The company is one of the leading producers of b-naphthol and exhibited this compound, as well as a-naphthol and a-naphthylamine. Sample dyeings of all the colors were present in abundance and the entire display gave admirable evidence of the energetic manner in which the older coal-tar color firms are extending the range of their operations.

Consolidated Color and Chemical Co., Newark, N. J.

This company manufactured a few colors on a relatively small scale before the war. It has not increased greatly the variety of its output, but is producing very large quantities. It displayed methylene blue, methyl orange, chromotrope, alizarin brown, acid yellow, cotton yellow, chrome black, chrome blue, chrome yellow, Victoria leather oil and a variety of sulfur dyes. Sample dyeings accompanied each color.

Marden, Orth & Hastings Corporation, New York.

This firm had a very tastefully arranged display of the products made in its seven factories, which included a large number of general chemicals, especially such as are required by dyers and tanners. The firm has branched out extensively into coal-tar products and showed the following:

Coal-tar Crudes and Intermediates.

Aniline oil, aniline salt, benzidine base, benzidine sulphate, benzol, beta-naphthol, chlor-benzol, dichlorbenzol, dimethylaniline, dinitro-naphthalene, dinitrophenol, hydroquinone, naphthalene, naphthionic acid, nitro-benzol, nitro-toluol, paranitraniline, phenol, picric acid, salicylic acid, salol, sulphanilic acid, toluidine mixture, toluol, xylidine, ortho-toluidine, para-toluidine, sodium naphthionate, sodium salicylate, sodium sulphanilate.

Acid Colors.

Acid black, acid blue, acid green, acid red, fast; croceine scarlet, orange No. 2, metanil yellow, acid yellow, azo orange.

Basic Colors.

Bismarck brown Y, chrysoidine Y, malachite green, methylene blue, methyl violet, nigrosine blue (water and spirit soluble), nigrosine jet (water and spirit soluble), Victoria blue S.

Chrome Colors.

Alizarin yellow R W, khaki No. 1 (for wool), anthracene acid brown G.

Direct Colors.

Direct black, Congo red, chrysamine G, direct blue, benzo brown G, benzo orange R.

Sulphur Colors.

Sulphur black, sulphur brown, sulphur yellow, sulphur blue, sulphur olive green.

Oil Soluble Colors.

Oil black, oil blue, oil brown, oil green, oil jet, oil orange, oil red III, oil red IV, oil scarlet, oil yellow, oil yellow D, oil yellow T.

The extraction of vegetable dyes is one of the company's specialties, and it introduced into general use aurantine paste and powder, obtained from our domestic osage orange. It exhibited the following:

Dyewood Extracts.

Logwood chips, logwood extract, hematine paste, hematine powder, hematine crystals, aurantine paste, aurantine powder, cutch, fustic extract, quercitron extract, sumac extract, cutch extract, hypernic extract, khaki No. 2 (for cotton).

The numerous samples, illustrating the use of the above colors, were grouped very effectively.

The Dow Chemical Co., Midland, Mich.

The exhibit of the many chemicals made by this company was extensive and impressive. The factory plant includes 260 buildings, and ranks among the most important of the country. Chief interest centered about the synthetic indigo, which is now being produced at the rate of nearly 2,000 pounds of 20% paste daily. The daily output will gradually be increased to 5,000 pounds. Much of the product is transformed regularly into dibromoindigo, which yields the most satisfactory results in cotton dyeing. Imports of the dibromo derivative from Europe were increasing prior to the war, and it is the feeling of the company that there is a large field for this compound. Prominent among the other coal-tar derivatives exhibited by the Dow Co., were synthetic phenol, salicylic acid, acetylsalicylic acid, methyl salicylate, ethyl salicylate, benzoic acid, sodium benzoate, sodium benzene-sulfonate, bromo-benzene, chloro-benzene, o-dichlorobenzene, p-dichloro-benzene, dinitro-phenol and tribromo-phenol. The acetic anhydride now produced by this company is of great importance to the synthetic color industry.

The Chemical Co. of America, New York.

The works of this company at Springfield, N. J., have become a leading center for the manufacture of coal-tar intermediates. Starting out early in 1915 with the production of aniline on a large scale, it has steadily enlarged the scope of its operations until it now furnishes most of the important intermediates. The following were exhibited: acetchlor-aniline, acet-toluide, amido-azo-toluol, aniline, aniline oil for red, anthranilic acid, Bayer's acid, benzaldehyde, benzidine base and sulphate, benzoyl chloride, benzyl chloride, chlor-aniline, chromotropic acid, diacetyl paramidophenol, dianisidine, diethylaniline, dimethylaniline, dinitrobenzol, dinitrochlorbenzol, dinitrophenol, dinitrotoluol, gamma acid, G salt, metanitraniline, metanitroparatoluidine, metaphenylenediamine, metatoluylenediaminel, monoethylaniline, naphtionic acid, nitro-benzol, nitrotoluol, ortho-nitro-chlor-benzol, ortho-nitro-paratoluidine, ortho-nitro-phenol, ortho-nitro-toluol, ortho-toluidine, para-amido-acetanilid, paramidophenol, paranitracetanilide, para-nitro-chlor- benzol, para-nitro-phenol, paranitrotoluol, paraphenylenediamine, para-toluidine, R salt, Schaffer's salt, sulphanilic acid, tetra-methyl-diphenylmethan, tolidine base and sulphate, toluidine, xylidine. The company has not yet taken up actively the manufacture of colors, but is making plans to enter this field at an early date.

The Seydel Manufacturing Co., Jersey City.

The company has undertaken the manufacture of benzoic acid upon a large scale, the annual output being 150 short tons. In its exhibit were the acid itself and the leading derivatives, sodium benzoate, b-naphthol benzoate, methyl benzoate and ethyl benzoate. Other products were benzyl alcohol, benzaldehyde, nitrobenzene, nigrosine, furamine (for dyeing furs), and a variety of sizings for textiles.

Newport Chemical Works, Inc., Carrollville, Wis.

This company is one of the few in the West engaged in the manufacture of coal-tar products. It utilizes the crudes supplied by the coke ovens of the Milwaukee Coke & Gas Co., and of the Northeastern Iron Co. It exhibited the various crudes, including phenol and pyridine, in a refined form, and the following intermediates: alpha naphthylamine, nitro naphthalene, di-nitro naphthalene, ortho-nitro toluol, para-nitro toluol, ortho-toluidine, para-toluidine, tolidine, 1 :3 :6 acid, H acid.

E. I. du Pont de Nemours Co., Wilmington, Del.

There was a diversified exhibit of fabrikoid and other products made by this company, apart from its main purpose of manufacturing munitions. The display of benzene, toluene, naphthalene, nitrobenzene, and dimethylaniline was limited to the raw materials which will serve in the extensive plans of the company to enter upon the production of dyestuffs.

The Calco Chemical Co., Bound Brook, N. J.

A very effective display of intermediates, including nitro benzol, aniline oil, aniline salt, dimethylaniline, dinitro-benzol, metaphenylenediamine, betanaphthol, sulphanilic acid, naphthionic acid, nitroxylol, xylidine and paranitraniline. The dyes regularly manufactured are: Acid colors—Scarlet 2 R, scarlet 2 R X, orange II, Bordeaux B, crimson Y, Bordeaux 2 B X, tartrazine. Chrome colors—Yellow, orange, green, brown. Basic colors—Methylene blue. Methyl violet. Direct colors—Orange R, maroon red, red, chrysamine, violet R. . Lake colors—Lake scarlet 2 R, lake scarlet 2 R X, acid orange, Bordeaux B, methylene blue, methyl violet. All of the dyestuffs were shown in solution. The sample dyeings were grouped together in a fan-shaped design, in front of which was an enormous cube of beta-naphthol. The whole arrangement was very effective.

The Williamsburg Chemical Co., Inc., Brooklyn.

The exhibit included the following intermediates: Benzylchloride, benzalchloride, benzaldehyde, benzoic acid, U. S. P., benzoate of soda, U. S. P., and dinitrochlorbenzol. But three dyestuffs are made by the company: Sulphur black, Malachite green, and Auramine. These were accompanied by sample dyeings. The whole display was very tastefully arranged.

New Jersey Products, Inc., Silver Lake, N. J.

Under this new designation appeared the products of the Thomas A. Edison Affiliated Companies. They were: Benzol, toluol, xylol, solvent naphtha, naphthalene, phenol, aniline oil, aniline salt, acetanilide, para-phenylenediamine, para-amidophenol base, para-amidophenol hydrochloride, para-nitro-acetanilide, benzidine, benzidine sulfate, acetyl-para-phenylenediamine. The coal-tar products made by the Edison companies are not many in number, but are manufactured upon a very large scale. Mr. Edison was one of the first, in 1915, to produce synthetic phenol and aniline in great quantities. He has limited subsequent expansion to a few important derivatives of these substances, notably para-phenylenediamine and para-amidophenol. Aniline is no longer produced for the market. The output of synthetic phenol continues, however, to be very large, and it is the intention to continue this feature indefinitely after the return to normal conditions, even in competition with phenol secured directly from coal tar. Both phenol and para-phenylene diamine are employed to quite an extent in the manufacture of records for phonographs and graphophones conducted by the Edison Co.

Butterworth-Judson Corporation, Newark, N. J.

A most imposing display was made by this company of the great variety of general chemicals manufactured in its extensive works. It is but recently that it has entered the field of coal-tar compounds. The list of intermediates now currently produced is, however, long and varied. The exhibit contained: Nitro-benzol, di-nitro-benzol, meta- and para-phenylene-diamine, benzidine sulphate, benzidine base, nitro-naphthalene, di-nitro-naphthalene, alpha-naphthylamine, naphthionic acid, ethyl-alpha-naphthylamine, methyl-alpha-naphthylamine, diphenylamine, H. acid, gamma acid, Neville and Winther acid, Schaeffer's acid, Cleve's acid, beta-naphthylamine, para-nitraniline, meta-nitraniline, para-nitrophenol, picramic acid, mono- and di-sulphonic acids, R acid, G salt, di-amino-tetra-methyl-benzophenone, di-amino-tetra-methyl-benzhydrol, benzal chloride, benzyl chloride, benzotrichloride, salicylic acid, salicylate of soda, methyl salicylate, phthalic anhydride, dimethylaniline. No colors were shown except Victoria blue and crystal violet. The company is now making phosgene and acetic anhydride on a large scale, especially for use in the manufacture of coal-tar dyes.

The Radcliffe Color and Chemical Works, Elizabeth, N. J.

Nigrosine is the chief product made at present. It was shown in all the standard forms, in blue, blue-black and jet-black shades, and oil, spirit and water soluble varieties.

The American Synthetic Color Co., Stamford, Conn.

The efforts of this company are now concentrated chiefly on intermediates. The products shown were picric acid, o-nitro-phenol, p-nitro-chloro-benzene, p-nitro-phenol and dinitro-chloro-benzene. The latter is the main element in the current output, and is supplied to manufacturers of sulfur black. The company is now producing large quantities of sodium nitrite, for the use of dyers and manufacturers of azo colors.

Empire Chemical Co., New Brunswick, N. J.

The activities of the company are devoted chiefly to intermediates. Its exhibit contained nitrobenzene, aniline, p-nitraniline, o-toluidine, p-toluidine, m-nitro-p-toluidine, p-nitro-o-toluidine, p-amido-phenol, and p-nitro-chloro-benzene. In addition there were various nigrosines.

King Chemical Co., Bound Brook, N. J.

The company displayed sulfur blue, sulfur black, methylene blue and primuline, accompanied by various direct reds, pinks, oranges and yellows. There was a good collection of sample dyeings.

Hellenic Chemical & Color Co., New York.

The dyes made by this company are methyl violet, methylene blue, bismarck brown, nigrosines, eosin, fuchsine, malachite green, and victoria blue. It specializes also in lakes and dry colors, and showed in this collection toluidine red toner, para red and para toner, phloxine lake and phloxine toner, magenta lake, rose lake and madder lake.

Dye Products & Chemical Co., Newark, N. J.

The company made a very creditable exhibit of intermediates and finished dyestuffs. The former included nitro-toluol, dinitro-toluol, meta-toluylene-diamine, diamine-developer C (crystals), toluidine, aniline and para-phenylene-diamine.

The chief colors represented were Naphthol green, Newark scarlet, Ponceau scarlet, Acid yellow, Chrome blue black, Chrome Brown, Copper purple, Chrysoidine, Eosin and Bismarck brown.

Madero Bros., New York.

This firm, while not manufacturing, is doing a large business as a distributor of chemicals, and especially of dyestuffs. It is rendering excellent service in building up foreign markets for our chemical products. It presented an excellent display of intermediates and of colors, including some made by the Monroe Drug Co., of Quincy, Ill.—notably H. acid.

Frank Hemingway, Inc., New York.

This company is, also, devoted largely to the distribution and export of chemicals and dyestuffs. It has, however, entered the field of coal-tar products, and manufactures on a large scale Michler's ketone, and various dyes made by its aid. The following colors were exhibited: Victoria blue B, victoria blue R, victoria blue 4R, crystal violet, malachite green, bismarck brown, primuline, safranine, paranitraniline, methylene blue. Attractive charts, with colored ribbons, outlined the genesis of each dye from coal-tar crudes.

Fifty intermediates were shown, among which were alpha-naphthol, alpha-naphthylamine, aniline, Bayer acid, benzidine, base and sulphate, benzaldehyde, benzyl chloride, beta-naphthol, beta-naphthylamine, Broenner's acid, dimethylaniline, dinitrobenzene, dinitronaphthalene, dinitrophenol, dinitrotoluene, diphenylamine, gamma acid (2:6:8), H acid (1:8:3:6), metaphenylenediamine, Michler's hydrol, Michler's ketone, naphthionic acid, Neville and Winther's acid, ortho-nitro-phenol, ortho-toluidine, para-amido-phenol, paradichlorobenzene, paranitro-phenol, paraphenylenediamine, para-toluidine, phenylaphanaphthylamine, phthalic anhydride, picramic acid, resorcin, R salt (2:3:6), salicylic acid, Schaeffer's acid, sulphanilic acid, tetranitromethylaniline, and xylidine.

A. Klipstein & Co., New York.

The exhibit of this long established firm, included numerous chemicals for the use of the dyer and tanner. Of especial interest were the sulfur dyes now made in quantity at Chrome, N. J., by the E. C. Klipstein & Sons Co. They embraced blacks, blues, yellows, browns and khaki tints. The zeta black is in demand for hosiery. Vat blues and indigo extract of this company are in extended use. An interesting feature was the collection of ciba colors and other coal-tar dyes, the products of the Basel Society of Chemical Industry, which the firm has imported regularly from Switzerland during the war, and which have done much to lessen the acuteness of the dyestuff shortage.

Geisenheimer & Co., New York.

This well-known importing and jobbing firm displayed a great variety of artificial colors, mostly from American works for which it is the selling agent. The most interesting feature of this extensive exhibit was the collection of dyes now made currently by the Ault & Wiborg Co., of Cincinnati, O. This company is one of the largest, if not the largest, producers of inks in the world. It requires normally very considerable amounts of a few staple shades. When cut off from European sources of supply in 1915, it promptly erected large works to furnish an adequate supply for its regular needs. The results were so successful that the output was notably enlarged both in quantity and variety. The colors exhibited were the following pigments: ambrose red, liberty toner and liberty red, all in various shades, and the following dyes: alizarin orange W, alizarin yellow G G W, chrome bordeaux, cloth red GO, acid bordeaux, acid orange No. 2, amaranth, azo crimson, brilliant acid orange G, croceine 3 B X, fast red A, induline N N, metanil yellow, ponceau G G, scarlet R R, tartrazine conc., eosin, erythrosin, Meldola blue and Bismarck brown R and Y.

The following intermediates, manufactured by Ault & Wiborg, were also shown: Amido-azo-toluol hydrochloride, amido-azo-benzol-hydrochloride, alpha-naphthylamine, alpha-naphthylamine-hydrochloride, alpha-nitro-naphthalene, aniline oil, aniline salt, Bayer salt 2:8, Broenner acid 2:6, beta-naphthylamine, beta-naphthol, dinitro-benzol, dinitro-chlora-benzol dinitro-toluol, monosulfonic acid F 2:7, nitro-benzol, nitro-ortho-chlor-benzol, naphthionic acid 1:4, Neville-Winther acid, ortho-toluidine, para-toluidine, paranitraniline, para-amido, acetanilide, para-nitro-chlor-benzol, phenyl-alpha-naphthylamine, R salt 2:3:6, Schaeffer salt 2:6, sodium naphthalene-beta-sulphonate, sulphanilic acid, tetra-methyl-diamino-diphenyl-methane and xylidine.

John Campbell & Co., Newark, N. J.

The company exhibited its "Amidine" series of direct cotton colors, the "Kromeko" series of fast chrome dyes, the "Aceko" series of acid colors and the "Liberty" series of dyes for the hat trade. The various intermediates employed in their manufacture were also shown.

Niagara Alkali Co., Niagara Falls.

This company is engaged extensively in the electrolysis of salt and markets the various soda products as well as chlorine, and bleach. It is now using large amounts of chlorine in the manufacture of chlorobenzene and exhibited this compound as well as dichlorobenzene. The latter was in the form of the commercial mixture of the isomers, as well as the pure ortho and para compounds. The whole exhibit illustrated admirably the degree of perfection attained in the development of the chlorine industry, as based upon electrolytic methods, and the use of the halogen in the production of coal-tar intermediates.

Hooker Electrochemical Co., Niagara Falls.

This company, also, had a fine display of the products of the soda and chlorine industry. It exhibited chlorobenzene, o-dichlorobenzene, p-dichlorobenzene, benzyl chloride, benzyl alcohol, benzaldehyde and benzoic acid. The manufacture of the last four compounds has been taken up quite recently.

This company was one of the first to show the advantage of transforming coal-tar crudes into their chlorine derivatives at the points where chlorine is produced electrolytically.

Merck & Co., New York.

In addition to a handsome display of alkaloidal, pharmaceutical and general chemicals manufactured by this company in their works at Rahway, N. J., there were exhibited a large number of their current coal-tar products. These included the pure hydrocarbons, benzene, toluene, xylene and naphthalene, aniline, p-nitraniline, acetanilide, benzidine sulfate, nitro-benzene, m-dinitro benzene, m-phenylene diamine, p-phenylene diamine, phenol, o-nitrophenol, p-nitrophenol, p-amidophenol, phenolphthalein, resorcin, hydroquinone, sulfocarbolates, b-naphthol benzoate, bismuth b-naphthol, salicylic acid, methyl salicylate, acetylsalicylic acid, acetphenetidin, salol, aurine, induline and nigrosine. The exhibit was instructive and revealed the wide range of activity of this long-established firm. Its coal-tar products are chiefly for medicinal and photographic use.

The Monsanto Chemical Works, St. Louis.

The exhibit of synthetic medicinals was finely arranged, and included the intermediates employed in making the different compounds. The coal-tar products shown were acetanilide, phenacetin, aspirin, phenol, U. S. P., phenolphthalein, saccharin, salicylic acid, salicylate of soda and salol.

This company is doing excellent work in establishing upon a solid basis the American manufacture of synthetic drugs from coal-tar crudes. It exhibited also vanillin, which it is now producing regularly.

Chromos Chemical Co., New York.

The exhibit was confined to fine samples of benzoic acid and sodium benzoate.

H. A. Metz Laboratories, Inc., Brooklyn.

The exhibit of this recently organized company contained an admirable display of its synthetic medicinals, salvarsan, novacain and anaesthesin. All of the intermediate steps in the production of salvarsan from aniline and arsenic acid were shown in carefully prepared samples. The establishment of the manufacture of this important synthetic drug on American soil is one of the leading features of the year's progress.

General Bakelite Co., New York.

Bakelite was shown in a great variety of forms, intended for the most diverse usages but chiefly in connection with electrical insulation. It is the trade name of a unique synthetic substance, oxy-benzyl-methylen-glycol-anhydride, discovered by Dr. L. H. Baekeland, after a series of brilliant research experiments, and is a condensation product of phenol and formaldehyde. In its pure form it is a hard, amber-like substance of pronounced chemical inertness. It combines high mechanical and dielectric strength with marked heat resistance and can be moulded with great accuracy and fine finish. It is also non-hygroscopic, impervious to water, steam, oils and most chemicals; has excellent weathering qualities, and will not warp, soften, swell or deteriorate with age.

This unusual combination of properties has rendered bakelite available for a great number of purposes. An especial degree of interest is attached to it as one of the few coal-tar products discovered in this country and introduced into general technical use.

The Stamford Extract Manufacturing Co., Stamford, Conn.

The successor to the old Stamford Manufacturing Co. displayed fine samples of the different dyewoods, as well as of quebracho, and the different extracts obtained from them in its large works. There were numerous examples of the results secured with them in dyeing. The hematin crystals were especially noteworthy.

The Obex Co., Marietta, O.

This firm is one of the latest to enter upon the production of dyewood extracts. It showed particularly fine cross-sections of Brazil wood, fustic, logwood and Osage orange, and a complete collection of the various extracts. The firm is planning to enter also upon the production of synthetic dyes.

Imperial Color Works, Glens Falls, N. Y.

Exhibits were made of lakes and toners made from p-nitraniline and from toluidine, in company with a variety of dry and pulp colors. There was also a good display of vegetable dyes manufactured in the plant of John H. Heald & Co., Lynchburg, Va. It included extracts of logwood, fustic and hypernic, hematine crystals, fustic crystals, wool and leather yellows.

The Buffalo Foundry & Machine Co., Buffalo, N. Y.

The exhibit of this company was the most imposing and the most extensive in the Exposition, occupying the entire western end of the main floor. It revealed in a remarkable way the complexity of the mechanism now employed in the production of chemicals and dyestuffs, and the contributions of mechanical engineering in this field. The company has been an important factor in furthering the rapid development of our domestic coal-tar chemical industry, by devising the requisite apparatus, and by rapidly supplying it in great quantities to newly organized firms.

The *pièce de resistance* at the Exposition was certainly its vast vacuum drum dryer, weighing 50 tons, with its two-stage dry pump, surface condenser and dust collector. One of the greatest successes in American foundry work is represented by the huge casing of the dryer, cast in a single piece.

A smaller vacuum drum dryer, in full operation, and an autoclave, holding 200 gallons, and working under 1,000 lbs. pressure, excited much interest, as did a jacketted receiver, an enormous nitrator, a capacious fusion kettle and a denitrator. There were numerous types of evaporators, for rapid circulation, for high concentration, for crystallization, with horizontal and vertical tubes, etc.

Among other forms of chemical apparatus shown by installation or plans, were: Acid eggs, acid concentrating apparatus, beta-naphthol plant, caustic flaking machines, caustic soda plant, causticizing apparatus, reflux condensers, crystallizers for TNT, ammonium nitrate, etc., vacuum crystallizers, expansion tanks, impregnating apparatus, nitric acid retorts and condensers, pumps, of many types; recovery systems for sulphuric and nitric acids, retorts (shelf type), salt filters, stills for aniline, beta-naphthol, phenol, etc., and sulphonators.

A large staff of engineers and chemists were in attendance, and the decorations and settings for the exhibit were in admirable taste. It testified in a striking manner to the exceptional claims which the chemical industry now makes upon the mechanical engineer.

J. P. Devine Co., Buffalo, N. Y.

A handsome exhibit of vacuum pumps, condensers, drying apparatus and high-pressure, cast-steel autoclaves, such as are now used extensively in making coal-tar intermediates and finished products.

The Pfaudler Co., Rochester, N. Y.

There was a fine display of the different forms of chemical apparatus, lined with resistant enamel, now required in variety by the manufacturers of coal-tar products, when dealing with strong acids. The specialties of this firm are highly appreciated in other countries, and a branch factory was maintained in Germany prior to the war.

Elyria Enameled Products Co., Elyria, Ohio.

The exhibit included a number of pieces of chemical apparatus, lined with enamel. This firm specializes in the production of enameled tubes.

Sowers Manufacturing Co., Buffalo.

An excellent display of steam-jacketted kettles, mixers, vacuum pans, etc.

Shriver & Co., Harrison, N. J.

Various types of filter presses.

United Filters Corporation, Brooklyn.

An instructive exhibit of new types of filters, in constant operation .

Kelly Filter Press Co., Salt Lake City.

Presses were shown in regular operation.

Arthur D. Little, Inc., Boston.

This firm is doing fine work as consulting and construction chemical engineers, and exhibited interesting evidences of the character of the work accomplished by its staff of 60, occupying a handsome building at Cambridge, Mass.

Civic, State and Railroad Exhibits.

A striking feature were the extensive collective exhibits of states, cities, railroad companies, and public organizations. Noteworthy in this connection were the large and instructive displays made by Louisiana and by Texas, as well as by the Southern R. R. system, the Carolina, Clinchfield and Ohio R. R., the Central of Georgia R. R., the Nashville, Chattanooga & St. Louis R. R., and the Norfolk and Western R. R. of Virginia. The South is making a vigorous effort to direct attention to the vast, undeveloped wealth in its territory, awaiting the advent of chemical industry. The great variety of samples and geological charts testified eloquently to the possibilities for creating manufacturing centers of mineral products in this section. The handsome exhibits of Baltimore and of Knoxville, Tenn., attracted much attention.

An official of one of the exhibiting railroads gave the following explanation of why his company found it desirable to participate in a chemical exposition:

"It might be wondered why a concern with but one product to sell, which, strictly speaking, is not competitive but is an essential—the absolute basis—of all industrial products, transportation should take the trouble, expend the money, and use up the time of part of its personnel to attend an exposition of this kind, but if you will look over the exhibit you will find that several railroads have done this. What is the reason?

"All railroads have at least two kinds of industries—those that 'just grow' and those that are planted. The first get there of their own accord, generally without the railroads' officials knowing or caring much about what was going on until their new neighbor began calling for cars; the second, the planted kind, often require nursing beyond the age when weaning is generally considered. These seem to me to be a middle ground, largely uninhabited, in matters of this kind which is much better for all concerned, and it is our firm belief, and I believe it is that of all of the increasing number of railroads who are taking advantage of this great opportunity to show their wares, that those roads which pursue a broadminded and liberal policy toward the intelligent aiding of new enterprises to become substantially established are they whose securities will be the real investment of the future."

ADDRESSES AND LECTURES.

In addition to all the many features appealing to the eye, not only in the diverse exhibits, but also in the daily production of many admirable series of motion pictures, portraying various phases of chemical industry, the management of the Exposition provided a very extensive list of lectures, addresses and symposia, dealing with a large number of chemical topics of timely interest.

In most of these the patriotic note was prominent and revealed the intense earnestness with which the American chemist faces his responsibilities during these days of strain and stress.

From the addresses the following extracts are made, as especially pertinent to the current situation or bearing upon topics connected with this section of the Chemical Engineer.

Mr. Roth Opens Exposition.

On the opening day Mr. Charles F. Roth, the manager of the exposition, in welcoming the assembled chemists, called attention to the fact that chemistry had swayed the balance of power among the nations, had revolutionized warfare, and made its ends more destructive and conquests more rapid. It had, in fact, transformed the entire industrial life of the United States and established the nation in the foremost rank of the industrial nations of the world. In closing he stated:

"A noted German chemist once said America was the natural home of the coal-tar industry. We are proving that now and building to make it permanently so. Not only of this industry is this true, but of all other chemical industries. Our raw materials have in the past been exported and returned to us in the manufactured form in which we used them.

"The exposition has done and is doing much to further the development of a complete cycle of domestic chemical industries. It will this year inspire us to a greater feeling of security for the future, showing that many fields are now efficiently producing and that we shall be in good position to not only fill all domestic needs, but to meet foreign competition in distant lands where a trade for the products of our chemical industries is already developed."

Dr. Charles H. Herty Praises American Chemists.

Dr. Charles H. Herty, chairman of the exposition advisory committee, followed with a stirring address, outlining the work now being accomplished by American chemists:

"The services of the chemist to the nation in these unusual times have been prompt, efficient and lasting Our soldiers soon to enter battle should be protected by the most lavish use possible of high explosives. Every possible pound of high explosive that this country can produce should be manufactured and transported to the European battlefields. Trench warfare has met its master in high explosives. The terrible sacrifice of life can be lessened by the curtain of artillery fire.

"There is no time to lose. High explosives must keep pace, nay, must increase faster than our man power. When writing out my address I did it by gaslight, and I hated the thought that I was burning gas which contains toluene, every trace of which should be on its way to Europe in the form of trinitrotoluol.

"Within the ranks of that army now being formed for battling in the cause of freedom are many of our young chemists—some from the industries, some the seniors and graduates from the universities. At Princeton all are gone, at the University of North Carolina every senior chemical engineer has enlisted. At the Massachusetts Institute of Technology the new course in chemical engineering has been abandoned until after the war, because all of the advanced men, who prepared to enter the course this fall, have enlisted, and so it goes all over the land.

"The battle for national self-containedness in that portion of the line held by the American chemist is progressing favorably. It is not yet won, but many heights have been conquered, many formidable streams crossed, and the open plains of full national service are almost in sight. The exposition, increasing in magnitude each year by 100 per cent. of its original size, constitutes the bulletin by which the nation is informed of the progress made.

"In the center," Dr. Herty continued, "the advance up the steep slopes of 'capitalization' has been marked. In 1915 there was added to the chemical industries $65,565,000, in 1916 $99,244,000, and in 1917, up to Sept. 1, $65,861,000, a total gain of $230,670,000. On the extreme right the forces of 'empiricism' have steadily yielded ground to the advances of our research chemists. More and more called upon for utmost effort, they have never failed to respond. On the left flank a steadily increasing force of the ablest American chemists is being gathered to capture the hill of 'obsoletism of army equipment' and is providing the great armies we are now raising with the most efficient forms of modern chemical means for both offensive and defensive warfare.

"On the right center the terrain of 'Congressional apathy' has been partly won, as typified by favorable protective legislation for our dyestuff industry and by the guarding of the all-important electrochemical industries at Niagara Falls from power shortage, due to lapsing legislation. On the left center the quagmire plains of 'public indifference' have been largely dried and made passable through the clearing skies of a sympathetic daily press, which has constantly emphasized the value to the independence of the nation of a full-rounded chemical industry. Finally, the counterattacks of subtle propaganda aganist the ability of American chemists and the worthiness of our products, such as American dyestuffs, have ingloriously failed. The optimism engendered by such splendid progress will prove, however, a curse, indeed, if it leads us to overlook the serious features of the present situation."

Prof. Stieglitz Tells of Progress.

Prof. Julius Stieglitz, of Chicago, president of the American Chemical Society, in his forcible address said:

"Every cloud has its silver lining, and even the great black cloud of war which has been oppressing the world these three years has been penetrated here and there by bright rays of good accomplished. One of these brighter effects of the disaster, so far as this country is concerned, has been the influence of the war on our chemical industries. Facing the necessity not only of very greatly expanding their output, but also of developing many new products and of making older products of a far higher grade in quality than ever before, our American industries, as evidenced by the three great expositions held in this place, have met and conquered one great problem after the other. We may confidently expect, and indeed we must insist, that out of this period of forced effort we shall emerge independent of all foreign nations in regard to our ability to supply the basic chemical needs of our country, not only in quantity but also in quality.

"As a single instance of the progress these years have witnessed in a field we must continue to hold after the war, let me recall the dismay of our universities—and, I am sure, also of our industrial laboratories—when early in 1915 we saw the supplies of Jena glass and of other finer glass cut off. Yet today we are manufacturing in the United States glassware as good as, if not, indeed, superior to, the German brands we thought we never could do without. When the war is over, no matter how fierce trade competitions may be, we must see to it that our new industries survive, that we do not relapse into our old dependence on European sources for almost every article in which quality, the higher quality, is essential.

"In the heat of effort of these years only the most urgent and immediate of our needs have been met. Some of these results still depend for their stability upon war conditions; they are still too liable to collapse when the world returns to its normal life and trade is free once more. In this situation, fraught with magnificent possibilities for much greater chemical achievements, but also with great dangers for the permanency of some of the American chemical industries, the American Chemical Society, for which I am speaking, sees its opportunity of being of new and still greater service to the country. Including in its membership of more than 10,000 the great majority of leading technical chemists as well as practically all the foremost men of the chemistry staffs of our universities and colleges, the society is in a position to render service in any branch of chemistry, service that will be expert and at the same time judicial and unbiased in its spirit.

"Thus, the society, influenced by the conviction that our national welfare demands independence in dye manufacturing, was active in aiding the movement to secure a much needed measure of protection by duties on dyes."

Dr. Colin G. Fink on Electrochemical Products.

Dr. Colin G. Fink, president of the American Electrochemical Society, said:

"Never before in the history of electrochemistry has the vast importance of the various electrochemical products been so forcibly brought to the attention of our Government and of our people as in the present year of the great war. Take from this country the electrochemical industry, with its numerous and diversified manufactures, and the martial strength of our country is hopelessly crippled. Think of the hundreds of machine shops that are utterly dependent on the electrochemical abrasives, carborundum and alundum! Think of the thousands of rifles and guns turned out every month with the aid of high-speed steel made from electric ferro alloys! Think of the millions of pounds of electrolytic copper that are absolutely essential for our electrical apparatus! There is the airplane, whose light, strong stays are made from the electrochemical metals aluminium and magnesium; there is liquid chlorine, a product of the electrolytic cell and basis of the Carrel-Dakin method of treating the wounds of our heroes; there is electrolytic hydrogen, used in all of our scout and observation balloons, and there are numberless electric alloys entering into the composition of nearly every item of the Government's vast military equipment."

More Chemists Needed, Says Prof. Bogert.

Prof. M. T. Bogert, of Columbia University, chairman of the chemistry committee of the National Research Council, outlined very fully and vividly the nature of the work now being done by American chemists to add to the country's effective power during the world conflict:

"Our committee was organized before the outbreak of the war by the National Research Council at the request of President Wilson through the agency of the National Academy of Science with the co-operation of the American Chemical Society. Its business consisted of: the co-ordination of scientific activities under various sub-committees; a census of research chemists. Returns from this census have been classified and indexed, and all sub-committees have been furnished with lists of chemists experienced in particular lines of work; detail of drafted chemists to positions of value. Already more than 300 individual problems of widest range have been given careful consideration, and reports made to various departments concerning these problems. Its chief function has been to serve as a central clearing house and coordinating agency for the chemical research work throughout the country. It serves also as a bureau of information by which accumulated information is given wide usefulness. It is estimated by the British authorities from their longer experience in such matters that only one suggestion in 300,000 proved to be of real usefulness. The committee has raised funds to meet the expenses of its own activities.

"As a result of the committee's experience to date, chemists are needed in the following lines: For teaching, the recruiting stations of the chemical laboratories being the educational institutions; for the control and direction of industrial operations of all kinds; munitions, gas, metals, leather, rubber, oils, paints, etc.; for the inspection and analysis of Government supplies; to identify poisonous gases, to detect poisons in water supply; for the development of new plants and processes throughout the country, these being called for by increased demand and cutting off of former sources of supply; for small scale manufacturing operations in educational and research institutions; for the security and defense of the country by protection against the enemies' contrivances; as advisers to the Government as to the best existing knowledge on various subjects and as to the best qualified men to initiate whatever research may be needed; in the Government laboratories to supplement the present forces. Many reagents and synthetic drugs, needed only in small quantities and therefore not of any particular interest to the commercial manufacturer, are now being made in universities and research institutions just as is being done in England, and thereby are furnished materials of utmost importance for the prosecution of the war and safety of the country."

"Drafted chemists should be exempted on account of industrial needs. They are rendering just as valuable and important service as those in the trenches and should be given insignia to indicate such exemption, as is done in France. At present there are more volunteers for research than problems to be solved. The committee is trying simply to supplement the work of the existing Government laboratories, but the number of problems is daily increasing.

"Military power is dependent upon scientific efficiency. This was no more strikingly illustrated than by the Germans, who replaced their exhausted supply of Chilean nitrate by atmospheric nitrate. It is difficult to talk on this subject with its many ramifications at a meeting like this, so I will talk on only one or two of its phases.

"One of these is hydrogen. It may not be believed, but it is true that the balloon and the submarine are problems in common. There is the necessity of analyzing the hydrogen used in inflating balloons for the discovery of foreign matter likely to be detrimental to the balloon's fabric. Then there is the development or creation of static electricity in the fabric of the balloon. That is another thing the chemist has to look out for.

"American chemists have devised two automatic hydrogen detectors and turned them over to the Government. The purpose of these detectors is to warn the submarine crew of the escape of chlorine gas from the storage batteries.

"The first gas attack was made by the Germans on April 15, 1915. Within four days after this first attack the Allies had equipped 3,000,000 men with temporary gas masks.

"At the present time there are 15,000 workers in England alone engaged in making masks for the military forces. They are turning out 20,000 masks a day, while contracts had been made for 25,000,000. One hundred and fifty chemists in this country are working on the gas-mask problem for the American soldiers."

Much Interest in Dr. Baekeland's Address.

Dr. L. H. Baekeland, in an address upon "The Future of the American Chemical Industry," brought out many important points:

"We have carried the mass production of synthetic explosives to a point never dreamed of. With truth, it can be said that if it were not for one of our largest chemical manufacturing companies, which promptly rushed to the rescue of the Allies at the beginning of the war and furnished them with explosives of which they were short, the war might have been ended a year ago in favor of Germany.

"Since then the chemists of France and England also have shown abundantly what they can do when conditions require it, and everything points out that after this war is over the supremacy of Germany in some of the chemical industries in which she heretofore was a leader will be a thing of the past.

"As far as the mineral chemical industries are concerned this country, even before the war, could stand excellent comparison with Germany or any other country. In fact, when it comes to the production of acids and heavy chemicals, the United States in several of these branches was decidedly ahead of Germany. There is no doubt, however, that we were behind in the manufacture of synthetic organic chemicals, which include the coal-tar dyes. But there was nothing strange or abnormal in this situation. The importation of these products in the United States before the war did not exceed $10,000,000 a year, this covering more than 1,000 different kinds of products, all of which require special processes of manufacture, and some having to be worked in very small units. As a business proposition, there was little to attract shrewd American business men.

"If Germany specialized in this branch of chemical industry, it was merely because she did not have the same opportunities for enlisting in other fields of enterprise. In this country we had new mines to exploit, new fields to cultivate, new railroads to construct, and many more industries of immediate importance claimed the full attention of our men of enterprise or scientific training. No wonder then that a little paltry industry of the kind was neglected.

"Nevertheless, as far back as the early seventies, a few enthusiasts started the manufacture of aniline dyes in the United States. They were making quite some headway, but in 1883 they had to perch through unfavorable tariff legislation. At that time German agents were already at work in this country and were leading our textile manufacturers by the nose and they helped them in their lobbying for the lowest tariff on dyestuffs, claiming that Germany would serve them, furnishing them with what they called their 'raw material.' This situation acted as a boomerang and paralyzed our textile industries at the beginning of the war.

"Since then, this country has realized that we must not estimate the value of the color industry in dollars and cents, but by the direct bearing it has as a key to all other industries. A few cents' worth of the right kind of dyes decides whether a hundred dollars worth of textiles can be sold or not in the open market. What is most extraordinary, almost a wonder, and bears witness to the flexibility and adaptability of American enterprise, is that in less than three years we should have made ourselves independent of Germany in the line where she had the start on us since half a century.

"The steady development of our industries of heavy chemicals, in the mineral or inorganic line, will very probably proceed as in the past. America's greatest development will consist in the further extension of industries in the organic field.

"In a country blessed beyond comparison with all the necessary natural resources for a large chemical industry, with a home consumption greater than that of any other country, we are very short of cheap water powers. Our great development of the electro-chemical industries in the United States was due to the fact that for the first time we placed at the disposal of our industries abundant electrical current, at lower rates than it has been obtainable in the past by means of steam. We became the leaders in those industries. Niagara Falls and its industries became a byword of electro-chemical supremacy throughout the world. Since then all other countries have gone us one better in the production of cheap water power. Unless we change our present condition, it looks as if our electro-chemical industries, our leading chemical industries, were going to be wrested from us to find a more inviting home in Canada and in Norway. Unfortunately, here again the condition is one of 'dog-in-the-manger' politics. A hydro-electric plant as a Government enterprise would not involve much of a new departure as compared with that splendid example of good engineering, the Panama Canal."

Mr. Kies on America's Chemical Exports.

W. S. Kies, vice-president of the National City Bank, told of the development of American export trade in chemicals. "The capital invested in chemical production from 1880 to 1915 has increased about eight times. The number of employees in the industry during that period increased but a trifle over three times and the wages and salaries paid increased about five times—from $6,000,000 to $31,000,000. In 1914 the chemical industries of this country exported in round numbers chemicals, drugs and dyes to the amount of $27,000,000. In the fiscal year 1917 these exports amounted to $185,000,000. In explosives, the value of our exports grew from $6,000,000 in 1914 to $820,000,000 in 1917. Under the heading 'other explosives' the value of our exports grew from $1,000,000 in 1914 to $420,000,000 in 1917, showing that in the industries closely allied with chemicals the growth has been quite as striking as in chemicals proper."

Dr. Hesse on the Tariff.

Dr. B. C. Hesse dwelt upon the relations of the tariff to the manufacture of coal-tar chemicals:

"There are not a few products of even the coal-tar chemical industry in which an import duty may in effect become a premium on inefficiency in operation and management, particularly in those cases where the costs of the basic materials employed are substantially the same at home and abroad in such cases, after the manufacturing technique has been acquired and a degree of efficiency in operation and utilization fairly comparable with the maximum has been achieved, the sole disability to the foundation of the industry will have been removed and domestic makers should then be in position to compete on those goods with foreign makers in our own markets without any artificial help through protective import duty and thus give these articles to such of our other domestic industries as use them at prices equal to those anywhere.

"In order that too much time be not taken in getting going, the conditional five-year limit to the life of the surtax of 5 cents per pound on certain dyes and of 2½ cents per pound on intermediates was obviously inserted in the present dye and allied chemicals tariff, which, in my opinion, is a very wholesome and a very equitable spur to our domestic manufacturers."

Mr. O'Reilly on "Chemistry and the Banker."

Mr. G. A. O'Reilly, of the Irving National Bank of New York, spoke upon "Chemistry and the Banker":

"The true relation of banking to chemistry is found in the theory of practical everyday business. This theory must be taken seriously and literally by both banker and chemist if they are to derive the greatest benefit from each other and from business. Regardless of tradition and of personal inclination, they must descend from their respective pinnacles, whether of financial exclusiveness or scientific preoccupation, and get together in the intensely practical and really very comfortable atmosphere which the thoroughly up-to-date business man of today has created and prepared for them. If in doing this it becomes necessary to disturb an occasional delightful fiction, or to smash an occasional professional idol, it is believed that both may be done to the entire benefit of all concerned.

"The theory that the true relation between chemistry and banking is found in business finds considerable justification even in conditions existing before the war. When viewed in the light of the big, wonderful new things which war has brought into the world, the conclusion becomes irresistible. The indifference with which in former years private interest viewed national problems and difficulties finds but slight resemblance in the magnificent response which business everywhere has made to the nation's call.

"And so while considering the business relationship between chemistry and banking we should concede sufficiently to the business advantages which will result to both from a proper getting together, we must not lose sight of the fact that the big thing in this relationship will be the national interest. For us there are just two worthwhile things in the world today—one, to win the war; the other, to protect American interests afterward. Naturally, winning the war comes first, but preparations to that end should be definitely based upon the understanding that wars are to be won principally that nations may live in greater peace and security and prosperity afterward."

Banker and Chemist Must Learn Common Language, Says Arthur D. Little.

Dr. Arthur D. Little, of Boston, the well-known chemical engineer, dwelt upon the same theme:

"The formation of indigo in the plant is a chemical reaction no less than when indigo is made by synthesis in the laboratory. Bankers were not particularly interested in the laboratory work until it became a commercial success, whereupon they began to take a decided interest in the credit of the indigo planter. Agriculture, which is so fundamental to the well being of any country, depends very largely upon chemistry, which makes possible fertilizers, furnishes data upon which methods of civilization may be based, and revises methods for the utilization of what would otherwise be an absolute waste. For example, the utilization of cottonseed has added more than a hundred million dollars annually to the value of the cotton crop, and cotton itself has become the raw material for very diverse chemical processes of the highest importance, such as explosives, celluloid, lacquers, and other well known items of commerce.

"The chemist is made to feel that he speaks a foreign language when talking to the banker, but events of the last three years are changing that. The flying corps risks its life daily solely for the advantage of a different viewpoint. The banker is in as great need of a new viewpoint, and can avail himself of it very much easier and without such risks. The waste that the chemists see on every hand really hurts, but it seldom moves the banker. The chemists through the prevention and utilization of these wastes could doubtless do more than any other profession in paying the debts of the war. This certainly should interest the banker. Of scarcely secondary interest is the chemistry of insurance, and the work which chemists can do in preventing the great annual fire losses. If Niagara Falls ran coal instead of water, how long do you suppose it would be maintained for the sake of a spectacle, and yet great obstacles have been placed in the way of the chemical engineer who would utilize Niagara's energy more fully than at present without seriously endangering the spectacle."

Dr. Little on Dyestuffs.

Dr. Little, on another occasion, discussed the dyestuff situation:

"Roughly speaking 75 per cent. of the dyestuffs needed are made in this country, and of this three-quarters, some are made in such excess that a considerable export trade is carried on with friendly countries, especially England.

"Of others needed there is a shortage, and this is serious in such basic colors as Magenta, Methylene blue, Auramine, Methyl Violet and a few more. The prices of many of them are way up, which has lured into the business a number of minor concerns in which the art is lacking to secure adequate yields. Some also are under incomplete chemical control, and they fail to purify their materials properly. This is incidental to pressing need and hasty establishment which the whip of time will correct. On the other hand, the very highest praise should be awarded to the conscientious manufacturers who have strained every nerve to meet the country's needs, often at the expense of profit.

"We have then three-quarters of the dyestuffs needed, some aplenty and others scarce. In regard to quality American-made dyes are the same as German dyes, only there are not so many of them. If some small makers are still short in their yields the loss is theirs. If they do not purify their materials enough the defect is more likely to be in shade than in fastness. This is a complete catalogue of the defects of American-made dyes and it does not apply to the products of the important makers. Nevertheless, dyers have been sorely put to it. They have had to use one material when they wanted another, and the substitutions have often been unhappy. They have also been compelled to relearn the art of using dyewoods for many purposes which are new to the present generation, and this is not to be learned in a day. The trouble, however, has principally come from the makeshift substitution of wrong materials for the right ones, because the right ones are lacking. The colors themselves are the standard articles whether made in Germany, France, Switzerland, England or here. And missing and scarce products are coming upon the market as agreeable surprises at short intervals."

Mr. McKerrow on Dye Situation.

H. Gardner McKerrow dwelt also upon the same topic:

"In point of quality American colors will, for the most part, compare well with the best imported colors. Both as regards brilliancy, fastness to washing and light, and general wearing qualities, the new styles are fully equal to the well known German type, as indeed there is no reason why they should not be, for the making of a dyestuff is, given the requisite intermediates of good quality, simply the following out of a fixed formula and the carrying out of certain prescribed successive steps.

"The industry is well established and there is no longer any fear of a shortage of dyestuffs, or a shutting down of factories on account of an absence of colors, and the new fashions are showing as much variety and brilliancy of shade as ever. It is true that some of the more delicate and fancy shades are not yet obtainable in American-made dyes, and it may be some time before these are forthcoming, for the simple economic reason that they are used in comparatively small quantities and only by certain specialized industries, such as certain kinds of silk manufacture. Doubtless these specialized manufacturers feel themselves aggrieved because their needs are not among those which have been filled, and are inclined to say

(Concluded on page 316)

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors.
Synthetic Medicinals, Flavors and Perfumes. Explosives,
Photographic Developers.

Edited by
THOMAS H. NORTON, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

George H. Bruce, LL.B., Keystone Fibre Products Co., Inc., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hebden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles.

H. Gardner McKerrow, of the Marden, Orth and Hastings Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

ARTIFICIAL COLORS

The Discovery of Primuline

By Arthur G. Green

[Professor Arthur G. Green, who occupies the chair of Tinctorial Chemistry in the University of Leeds, contributes to the Journal of the Society of Dyers and Colourists the following interesting account of the circumstances attending the discovery of the valuable dyestuff Primuline. The article can be read with profit by all engaged in the manufacture of coal-tar colors, and especially by those entering upon the field of research. Prof. Green, in addition to his work as an investigator and teacher, is the author of the English edition of Schultz and Julius' "Tables of Organic Coloring Matters," and of "The Analysis of Dyestuffs" (1915).—Ed.]

In reading the published accounts of the early history of the coal-tar color industry I have often noted with regret the great paucity of information regarding some of the most important discoveries. Many interesting and valuable facts which could have been supplied by the pioneers of the industry have, through want of a historian, never been chronicled, and, now that most of these early workers are unfortunately no longer among us, must of necessity be lost. I have therefore thought that it might be of interest to the Society of Dyers and Colorists if I recorded, while there is yet time, a few personal reminiscences of a discovery which, though of less importance than some others which preceded it, has, nevertheless, come to be regarded as a landmark in the evolution of the dyestuff industry and of the art of dyeing.

The discovery of primuline took place in 1887 under circumstances which form an interesting illustration of the important part played by chance in very many discoveries. In the autumn of 1886 I was engaged in the laboratory of the late firm of Brooke, Simpson and Spiller, of Hackney Wick, London, in making a study of the sulfonation of amido-azobenzene with the object of producing an azo crimson for wool. I had entered the service of this firm at the age of twenty-one, direct from college in the previous year, and had, therefore, had but little experience of chemical manufacturing, although during the latter part of my University course I had enjoyed the advantage of being able to spend a portion of my summer vacations in the works of Messrs. Williams Bros. and Ekin, of Hounslow. While I was engaged upon the above-mentioned experiments, my attention was attracted to a patent taken out by the firm of Dahl and Co., of Barmen, which described the production of a new base said to be isomeric with diamido-ditolyl sulfide. As this base was stated to give a maroon when diazotised and coupled with b-naphthol-disulfonic acid, I thought its sulfonic acid might be used as a substitute for amido-azobenzene-sulfonic acid, the preparation of which had given me some trouble. Upon preparing this so-called "thiotoluidine" by the method of the patent I obtained only half the expected yield, while the other half of the p-toluidine remained unaltered. Furthermore, by titration with nitrite the base produced was found to contain only one amido group instead of two. Closer investigation showed that the reaction actually required four atomic proportions of sulfur to two molecular proportions of p-toluidine, and that the product (now known as dehydro-thiotoluidine) had the empirical formula $C_{11}H_{12}N_2S$. Upon treatment with fuming sulfuric acid it gave a sparingly soluble monosulfonic acid, the ammonium salt of which was also sparingly soluble. In studying the azo derivative obtained from this base and from its sulfonic acid the interesting discovery was next made that many of these dyestuffs had a substantive affinity for cotton. At this period the benzidine colors, discovered three years previously, were claiming much attention, and it was generally held that only azo compounds derived from paradiamines would dye cotton without a mordant. Here, however, was a class of direct dyeing cotton dyestuffs derived from a *mono* amine.

While the investigation of these new colors was proceeding, a paper appeared in the Berchte of the German Chemical Society by Möhlau (Ber., 19, 2,014), which attributed the direct affinity for cotton of the benzidine dyestuffs to the presence of the diphenyl residue, and in support of this contention asserted that cotton boiled in a solution of the hydrochloride of benzidine itself, took up and fixed the base, which could subsequently be converted into Congo Red on the fiber by passage through an acidified solution of sodium nitrite followed by sodium naphthionate. Knowing that my new sulfonic acid, like benzidine, gave substantive cotton dyestuffs, I was interested to see whether it also would exhibit a direct affinity. For trying the experiment I used the sodium salt of the unpurified sulfonic acid obtained by sulfonation of the crude thio base formed by heating 2 molecular proportions of p-toluidine with 4 atomic proportions of sulfur, and found that a hot solution of this product immediately dyed cotton a bright primrose yellow, while upon passing the cotton thus dyed through a solution of nitrous acid and thence, after washing, into solutions of naphthols, phenols or amines, a whole series of colors were obtained which exhibited great fastness to soaping. Thus in half an hour I was able to obtain on the fiber a yellow, orange, red, crimson, maroon and purple.

I was now much interested to prepare the new sulfonic acid in a chemically pure state, especially as I was somewhat astonished that it should dye cotton yellow, as I believed its salts to be colorless. As a means of purification, I accordingly prepared the sparingly soluble crystalline ammonium salt. This was, in fact, without color, but to my surprise exhibited no affinity for cotton whatever. On the other hand, the filtrate from which the ammonium salt had separated dyed as before. It was, therefore, clear that it was not the sulfonic acid of the so-called "thiotoluidine" which exhibited this property, but the sulfonic acid of another compound accompanying the "thiotoluidine" in the crude base, the ammonium salt of which differed from that of the former by being easily soluble. It occurred to me that this might be a more complex thio compound, and I accordingly made melts with a still larger proportion of sulfur, obtaining in fact an increased yield of the direct-dyeing sulfonic acid at the expense of the sulfonic acid of the simpler base. Further experiments showed the best condition for its preparation, and in the summer of 1887 the sodium salt of the sulfonic acid was put upon the market under the name of "Primuline," this name being derived from the word "Primula," the generic term for plants to which the primrose and cowslip belong.

And now I must mention a curious fact. It was not until a year or two later that I was led to repeat Möhlau's experiment upon the direct affinity of benzidine. Much to my surprise, I found that the supposed observation of Möhlau, which led me to try the experiment which disclosed the direct affinity of the sulfonate of the higher thionated p-toluidine, was an entirely erroneous one. Not a trace of affinity exists between cotton and benzidine, a fact which was also corroborated later by Levy. It is curious to reflect that had I first stopped to test the validity of Möhlau's statement, or had I used for my experiment the sulfonic acid of pure dehydro-thiotoluidine, I might never have discovered Primuline.

The chemical structure of Primuline and the related dyestuffs remained in doubt for some time after their discovery, and was only ascertained with certainty after a considerable amount of scientific work extending over the two following years, and in which several German investigators also took part. The dyeing properties of Primuline were first announced in the "Dyer" for July, 1887, and a full account of the dyestuff and of the "ingrain" process was communicated to this Society at Bradford on February 9, 1888, and published in the "Journal" for that year (page 39).

My firm unfortunately were not enthusiastic about the value of the new discovery. The managing director, upon being shown the diazotisation and development of Primuline, remarked sarcastically, "Yes a very pretty experiment; you had better show it to the Chemical Society!" inferring that it had no commercial value. If it had not been for the encouragement given me by the late Mr. Edward Brooke the dyestuff might never have been introduced into commerce. As it was, nothing would persuade them to patent it. To my urgent requests in this direction they replied, that either the discovery was valueless, in which case a patent would only be a waste of money, or if it was of value a patent would disclose its composition, and enable competitors to manufacture it, for after their previous experience with the Magenta patent they would never engage again in a patent action and, therefore, could not defend the patent if infringed. I prepared draft specifications for three separate patent applications, covering (1) the manufacture of Primuline, (2) the production of dyestuffs upon the fiber by the diazotising and developing process, (3) the production of a variety of azo dyestuffs in substance derived from Primuline and dehydro-thiotoluidine sulfonic acid. My board of directors, however, declined in their superior wisdom to apply for any of these suggested patents, which would have covered an enormous field and have been of immense value to the company. By this action and others of a similar character they condemned their firm to continued decadence and to ultimate extinction, while at the same time the whole dyestuff industry of England was adversely affected. Who can doubt that had a more enterprising policy been followed the stimulus of successful progress would have reacted advantageously on other English firms, and have given encouragement to other English chemists to devote their abilities and energies to dyestuff research? Even when the commercial success of Primuline was assured, my firm declined to make any adequate recognition for the discovery, and only after considerable pressure did they consent to pay a small commission. The last payment of this commission, covering the six months preceding my leaving the service of the company in 1893, amounted to the large sum of 83 cents, although the sale of the dyestuff remained undiminished and the average price was then about 60 cents per pound. I only mention these facts to show the small encouragement which was given to young chemists at that period.

The result of the policy of secret manufacture which they preferred to follow was exactly what might have been foreseen. Upon the appearance of Primuline in commerce the German firms at once recognized its importance, and submitted it to chemical examination. Its composition was quickly solved, and within a year or two its manufacture was commenced by two of those firms (the Farbenfakriken F. Bayer and Co. and Messrs. Dahl and Co.), while a third (Messrs. Meister Lucius and Brüning), supposing the dyestuff to be patented, applied to my firm for a license, and had to be informed that they were free to manufacture it if they knew how. The Badische Anilin Co., who also unravelled its composition, were dissuaded by Dr. Caro, on moral grounds, from undertaking its manufacture, but commenced a few years later. Dr. Ehrhardt, the late head of the patent department of this firm, stated in a recent publication that from computations which he had made, based on the sales of Primuline by his own and other German firms, he had no hesitation in saying that "with adequate protection the invention of Primuline alone might have brought in a princely income, and, properly managed, should have contributed largely towards placing the (English) factory in the front rank of chemical manufacturers of the world."

Manufacture of Copper Compounds of Ortho-Oxy-Azo Dyestuffs

We have had occasion to describe various new dyestuffs obtained by Dr. Carl Jagerspacher of Basel and his associates, on treating ortho-oxy-azo dyestuffs with copper compounds in the presence of a solvent.

In a later patent (Amer. Pat. 1,237,183 of Aug. 14, 1917) Dr. Jagerspacher and Dr. G. Engi find that instead of starting from the ortho-oxy-azo dyestuffs and acting with copper compounds on their solutions, the new copper compounds can also be obtained by effecting the combinations of ortho-oxy-diazo-phenol or ortho-oxy-diazo-naphthol derivatives with azo dyestuff components, in presence of copper compounds. Thus the copper compounds of the ortho-oxy-azo dyestuffs are produced directly and can be isolated eventually after addition of common salt, by filtration, washing and drying.

In this connection they make the observation that generally the combinations in presence of copper compounds occur more easily than according to the hitherto usual methods. The reaction is facilitated in such a manner, that certain combinations, which could not be carried out, or could only be carried out with low outputs, according to the usual methods, can be executed now easily and with excellent yields by effecting the reaction in presence of copper compounds. While for instance the combination of the diazo derivative of 1:2:4-amino-naphthol-sulfonic acid with 1:5-naphthol-sulfonic acid was, according to the known methods, very incomplete and the yield extremely low, the yields of copper compounds of the said ortho-oxy-azo dyestuff obtained according to the new process in presence of copper salts are almost quantitative.

The new process is illustrated as follows:

Example: To a concentrated solution of 25 parts 1:5-naphthol-sulfonic acid and of 40 parts sodium carbonate in water is added, while stirring, a solution of 24 parts copper sulfate in 60 parts water. In the solution thus obtained is introduced, while stirring, the diazo derivative of 24 parts of 1.2:4-amino-naphthol-sulfonic acid, prepared in the usual manner. After stirring for 24 hours at ordinary temperature, the reaction mass is heated progressively to 40° C. and maintained at this temperature until the combination is achieved. After separation of the copper hydroxide in excess by filtration, the copper compound is precipitated from the solution by adding common salt. It dissolves in water with violet-red and in concentrated sulfuric acid with blue coloration and dyes wool in an acid bath pure violet tints fast to light, washing and alkalis.

New Azo Dyes from Chromotropic Acid

James H. Stebbins of No. 80 Madison Avenue, New York City, has recently patented (Amer. Pat. 1,235,253, of July 31, 1917) a new class of dyes, derived from chromotropic acid, or 1.8-dioxy-naphthalene-3.6-disulfonic acid,

$$C_{10}\,H_4\,(OH)\,(SO_3H)\,(SO_3H)\,OH\ [1:3:6:OH]$$

The new dyestuffs are derived from the acid, by combining it with diazotized benzidine, or its equivalent, and with another diazotized aromatic amine, such as diazotized p-nitraniline or diazotized p-amido-phenyl-glycine or diazo-picramic acid; and by further combining with the diazotized benzidine an end component such as 1.5-naphthol-sulfonic acid or the 1.4-naphthol-sulfonic acid.

The dyestuffs are characterized by the following constitution:

$$R—N:N—R_1—N:N—R_2—N:N—R_3$$

in which R_1 is the nucleus of the chromotropic acid, R_2 the diaryl nucleus of benzidine or its equivalent, R_3 an aromatic nucleus of an end component such as a naphthol-sulfonic acid, and R an aromatic nucleus derived from a diazotized aromatic amine such as those referred to above. These dyestuffs form blue, black or brown products, soluble in water and capable of dyeing cotton in sodium sulfate baths bluish or purplish shades, and also capable of dyeing wool in acid sodium sulfate baths blue to black or brown shades. Mordants are not required in either case.

The following example illustrates the general method:

Example 1: 13.8 kgs. of p-nitraniline are diazotized in the usual way by treatment with 60 liters of hydrochloric acid of 1.2 specific gravity, diluted with 200 liters of water, and 6.9 kgs. sodium nitrite dissolved in 200 liters of water. The diazo-p-nitraniline chloride solution thus obtained is then gradually stirred into a solution of 40.4 kgs. of the sodium salt of chromotropic acid in 100 liters of water. At the end of the operation, it will be found that the solution has a strong acid reaction. A bright scarlet dyestuff is thus obtained. The dye solution is allowed to stand over night. It is then made alkaline by the addition of 140.0 kgs. anhydrous sodium carbonate which is sufficient to neutralize the 60 liters of hydrochloric acid previously used and 37.5 liters of hydrochloric acid to be used in the next operation. A dark blue precipitate with a purplish solution is formed. On heating to boiling the precipitate is dissolved yielding an intensely purple solution. On cooling the dyestuff separates in the form of its sodium salt, as a semi-solid mass of crystals. The crystalline mass is then broken up by stirring and treated under constant stirring with one molecular proportion of tetrazo-diphenyl chloride. The solution immediately turns back with the formation of a black precipitate of the new intermediate product. The mixture is allowed to stand in the cold for about 6 hours. There is then stirred into the same a solution of 22.4 kgs. of 1.5-naphthol-sulfonic acid dissolved in 300 liters of water and the whole is made alkaline with 16 kgs. of caustic soda. The black precipitate of the intermediate begins to dissolve immediately, yielding a violet-colored solution. On standing, it is ultimately transformed into a violet-black precipitate with only a small amount of coloring matter in solution. The precipitate is filtered off and dried.

The new azo dyestuff thus produced dissolves in hot water with a bluish Bordeaux color. On cooling it partly separates out again. It dyes unmordanted cotton in a neutral sodium sulfate bath a bluish shade. Silk and wool are dyed in an acid bath of sodium sulfate various shades of brown to black, depending upon the quantity of dye used.

The tetrazo-diphenyl chloride referred to in the above example may be prepared from benzidine as follows:

18.4 kgs. benzidine are dissolved in 37.3 liters of hydrochloric acid of 1.2 specific gravity and 300 liters of water. The solution is cooled with ice and diazotized by treatment with 13.8 kgs. sodium nitrite dissolved in 300 liters of water.

New Class of Dyes from Patent Blue

Dr. Fritz Funcke and Dr. Carl Jagerspacher, of Basel, Switzerland, assignors to the Society of Chemical Industry (Amer. Pat. 1,237,192 of Aug. 14, 1917), describe a series of leucotriaryl-methane dyestuffs obtained by diazotizing the amido-leucopatentblue, resulting from the nitration of leucopatentblue and subsequent reduction, and by combining the diazo body with an azo dyestuff component, as for instance an amine, a phenol, a naphthol, an aminophenol, an aminonaphthol or their sulfo or carboxyl derivatives, pyrazolone derivatives, etc.

The new dyestuffs dye on mordant and are especially applicable for dyeing animal fibers vivid blue to green tints, fast to washing and light. They constitute blue to green and yellow powders, soluble in water, with blue to green and yellow colorations and in concentrated sulfuric acid with yellow to violet colorations.

The new process may be illustrated by the following example:

Example: 57 parts of amido-leuco-patentblue prepared by nitrating leuco-patentblue (dyestuff obtained by condensing m-nitro-benzaldehyde with diethyl-aniline, reducing the resulting nitro body, diazotizing, boiling the resulting diazo derivative and transforming the thus obtained oxy body into disulfonic acid, with a mixture of nitric acid and sulfuric acid and reducing the resulting nitro derivative, are dissolved in about 250 parts of water at 40° C. and 25 parts soda lye of 30%. To the solution thus obtained are added 7 parts sodium nitrite and the mass is acidulated at 0° C. by adding 40 parts concentrated hydrochloric acid. The resultant solution of the diazo derivative is poured into a solution, as concentrated as possible, of 14 parts b-naphthol, 13 parts soda lye of 30% and 50 gr. sodium carbonate. After the mass has been stirred or allowed to stand for several days, the combination, which proceeds very slowly, is completed and the dyestuff is salted out. It constitutes a blue powder dissolving in water with a blue and in concentrated sulfuric acid with a brown-violet coloration. It dyes wool in an acid bath green-blue tints, which by their treatment with chromium compounds become fast to washing and to light. They turn to a blue fast to washing and to light by treatment with copper compounds.

In an additional patent (Amer. Pat. 1,237,193 of Aug. 14, 1917) the inventors describe, as follows, the preparation of copper derivatives of the dyes in question:

Thirty-five parts of the dyestuff, obtained by combining the diazo derivative of amido-leuco-patentblue with b-naphthol, are dissolved in 1,000 parts tepid water. To the solution is added at 70° C. a solution of 13 parts of crystallized copper sulfate in 50 parts water, whereby the green-blue coloration of the solution turns to blue. The resulting copper compound is precipitated by addition of common salt, isolated by filtration, pressed and dried. It constitutes a blue-black powder, soluble in water with blue and in concentrated sulfuric acid with green coloration. The new copper compound dyes animal fibers in an acid bath pure blue tints very fast to light and to washing. Especial importance is attached to the copper compound of the dye-stuff derived from the diazo derivative of leuco-amido-patentblue and 1-phenyl-3-methyl-5-pyrazolone. This constitutes a black-green powder soluble in water to a pure green solution and in concentrated sulfuric acid to orange red solutions. It dyes animal fibers in an acid bath pure green tints, fast to washing and to light.

NATURAL DYES

Development of the Natural Indigo Industry in India

By Professor H. E. Armstrong

[The growing interest in the possibilities of re-establishing the widespread use of natural indigo was briefly mentioned in the June issue of this journal, page 137. The following study by Professor Armstrong, a leading British chemist, will be read with interest in this connection. As stated in our June issue, the problem is one of importance for our South Atlantic States, in which the culture was pursued so successfully during the 18th century.—Ed.]

So-called "synthetic indigo" has been manufactured in large quantities of late years, mostly in Germany and to a much smaller extent in Switzerland, the raw material being derived from coal tar. It is usually supplied in the form of a paste containing 20 per cent. of the dyestuff, free from impurities apart from water. The term "synthetic," be it noted, is applied to all substances "put together" in the laboratory. Synthetic indigo consists of a single definite compound known as *Indigotin.* Natural indigo contains this same indigotin, together with certain impurities, of which there is rarely less than 30 per cent. In addition, it regularly contains small but varying amounts of indigo red. The presence of this latter constitutes the main difference between the artificial and natural indigo as a dyestuff. Synthetic indigo has now a strong position, particularly among calico printers, because it may be completely discharged, leaving clear whites on patterned goods. It has no advantage, as a dyestuff, in dying heavy uniform shades. Indeed, most dyers give the preference to natural indigo for this purpose, owing to the effect the indigo red has on the shade, though few, if any, are prepared to pay a higher price for it on this account. Natural indigo was ousted from the market mainly because of its irregular composition; also because of the difficulty and cost of grinding it to powder.

The amount of "synthetic" paste produced in 1913 is believed to have been about 55,000 long tons, of a value of $16,070,000. The export to Great Britain in 1913 was 1,180 tons; to India, 324 tons; and to China and Japan about 27,000 tons.

The export of natural indigo from India, reduced to a basis of 20 per cent. paste, was slightly over 2,000 tons in each of the years 1910-11 and 1911-12. It fell to less than 1,500 tons in the two following years. It then rose to 2,142 tons in 1914-15, and to 5,242 tons in 1915-16.

Outlook for Industrial Revival.

When in Calcutta in November, 1914, I found that the revival of the industry was already under discussion, owing to the fillip which the war had given to the sale of indigo. I then took the opportunity of gathering what information I could. My opinion of the prospects was expressed in a letter, which I wrote before leaving to the *Statesman,* of Calcutta, in the following terms:

"If the advantage gained by natural indigo through the war is to be maintained, I believe it will be necessary for planters, in future, in some way to arrange to bulk their products and put upon the market a paste of fixed composition, comparable with that supplied by the Germans.

"I cannot help thinking that it should still be possible to secure a fair share of the trade for natural indigo in competition with the synthetic article. The possibilities in the way of effecting improvements, especially in agricultural practice, in the plant itself and in the process of manufacture, seem to be in no wise exhausted. Our understanding of such matters is now so much greater than it was even 10 years ago. Various inquiries have studied this or that side of the problem, but apparently no attempt has been made to deal with the subject comprehensively from the many points of view, from which it must be regarded, if success is to be assured. The men who have been engaged have not had the all-round knowledge or the ripened ability as investigators that is required to deal with the many issues, scientific and economic, that are involved. It cannot be insisted too strongly, in fact, that the problem is one requiring very special knowledge and acumen. But it is nothing short of a disgrace to us that such an industry should be allowed to lapse in a country where the need of native industries is so great. The recovery of the position of natural indigo may be a costly business; but if one-tenth of the zeal, put by the Germans into the production of the artificial pigment, is brought to bear on the problem, I believe it will be solved satisfactorily."

An official conference was held at Delhi early in 1915, and as a result the matter came under discussion at the India Office. Eventually an agreement was entered into with the Bihar planters, and it was resolved that the necessary steps should be taken to study and develop the industry with competent scientific aid.

Considerable progress was made last year. Important improvements are already foreshadowed in agricultural practice, which should increase the crop and render it more certain. It is also clear that the methods of extracting the dyestuffs may be developed so as to increase the yield and improve quality. Not least important, the advantages to be derived from co-operation are being brought home to planters. Recently the Madras Government has consented to the imposition of a small duty on exports of indigo. The proceeds are to be utilized in carrying on experimental inquiry. Steps are now being taken here to reduce Bengal indigo to a paste of uniform composition before offering it to dyers.

It has already been demonstrated, on a practical scale, that natural indigo may be produced and sent here in paste form, comparable with that in which synthetic indigo is put upon the market by German and Swiss manufacturers.

I am strongly of the opinion that dyers, therefore, should not commit themselves, in advance, too hastily to the synthetic product, and regard this as the more suitable material. They may expect that natural indigo will be supplied in all the various forms in which it is now required, ready for use, eventually at prices which will put it on a level with the artificial material, manufactured by German methods, even if made here. It is essential, however, that users should, for a time, give their patriotic support to the effort.

Algarrobin

The bark of the carob tree, occurring in great abundance in Argentina, contains notable amounts of a natural dyestuff, the extraction of which has recently assumed industrial importance.

Algarrobin, as the extract is termed, contains a high percentage of tannic acid, and is found to give excellent results in tanning. The tinctorial properties are, however, so marked that it is felt as if a very distinct field may be open for its use in dyeing. It is susceptible of application to both animal and vegetable fibers, imparting a clear chestnut brown, which is very fast to both light and washing.

The most advantageous use of algarrobin appears to be in conjunction with other vegetable dyes. It modifies tints and simultaneously, on account of the high tannin content, acts as a mordant. There appears to be, also, an abundant opportunity for its use as a bottom for numerous coal-tar dyes.

In the weighting of silk algarrobin may come into close competition with gambier, as the fiber absorbs materially larger amounts of the former. When used alone the color imparted to the silk is brown as compared with the yellow of gambier. The addition of tin phosphate to the bath gives a much darker lake than in the case of gambier, and the iron lake is practically black. In all cases silk weighted with algarrobin is equal in feel and luster to that treated with gambier, and frequently superior.

France and Italy are now employing large amounts of algarrobin for dyeing khaki and olive drab on military uniforms. It may be of marked assistance in meeting the heavy demand for coloring materials, associated with the manufacture, on so extensive a scale, of the fabrics required to clothe the American army in the immediate future.

The dye is produced regularly in a factory at Santa Fé, in the Argentine Republic, with a daily capacity of over six tons. McKitterick and Simpson, 200 Fifth Avenue, are the New York agents.

The British Imperial Institute published recently the following details on the methods of dyeing with algarrobin, secured through correspondents in Argentina:

Cotton—The cotton is placed directly in the algarrobin bath, the dye to be dissolved in pure water, adding at the most 200 grammes of acetic acid to 100 kilos of the extract. It is not necessary that the solution boil during the dyeing, but sufficient if the bath is kept at a good heat during from ½ to 2 hours for the dark colors and from ½ to 1 hour for the lighter shades. The spools must be stirred from time to time, and it is preferable to keep them submerged.

The cotton dyed in this manner is left to drain and cool in the open air, and is then placed in the mordant bath (mordant of iron cold and other mordants lukewarm); it is recommended to see that the color is well fixed before taking the cotton out, afterwards washing with care.

To Dye Cotton Black—First bath: Dissolve the algarrobin in boiling water at the rate of 25 per cent. of the weight of cotton to be dyed, for the first bath only; for the following lots it will be sufficient to add about 10 per cent. every time for the bath to retain its strength (it is advisable to add 1 per cent. of logwood or ematina). The cotton is placed directly in the dye, stirring well, so that every part gets well soaked, then submerging entirely during from two to three hours, after which the cotton is brought to the surface again, stirring repeatedly. The yarn so dyed is taken from the bath, and when the dyer has brought the bath to its original strength the second lot of cotton is put in it.

Second Bath: After the first lot of cotton has remained in the open long enough to be thoroughly oxidized, it is placed in a 5 per cent solution of sulfate of copper of a temperature from 40° to 50° C., stirring continually until the mordanting process is quite completed (about 1 hour), then washing, using fresh water twice and stirring well. The shade then obtained must be very dark brown.

Third Bath: Dissolve in boiling water 1 per cent. ematina (the alkaloid obtained from ipecacuanha), or 2 per cent. logwood extract, and soap 0.2 per cent The yarn is placed in this bath, stirring immediately, so that the fluid covers the spools evenly. After ½ to ¾ of an hour a perfect black is obtained; wash and dry immediately.

When dyeing with two men and two tanks, one for the algarrobin solution and the other for the second and third baths, three lots of cotton have to be worked at the same time:—One lot, 50 kilos, in the algarrobin solution; one lot, 50 kilos, exposed to the open air; one lot, 50 kilos, passing through second and third baths.

It is recommended that mordanting be done with the greatest care, and the solution must be spread rapidly over the entire spool in order to obtain a uniform shade. The same applies to the ematina or logwood bath. If in the mordant bath the color becomes greenish, 1 per cent. of iron, thoroughly dissolved, must be added.

The cost of dyeing black with algarrobin works out at:—

Algarrobin	15% at $1.50 =	$22.50
Sulfate of Copper.......	4% at .75 =	3.00
Ematina	1% at 10.00 =	10.00
Labor and general expenses, 20%........		7.10
Total cost for 100 kilogs. cotton..........		42.60

Dyeing of Wool and Silk—As in the case of all animal fiber, it is recommended to apply the mordant before dyeing. For the Havana brown shades the best results are obtained with bichromate of potassium (or sodium) as a mordant.

To Dye Black—First Bath: Bichromate of potassium, 1 per cent.; sulfate of copper, 3½ per cent.; sulfuric acid, 1½ per cent. Soak from 1 to 1½ hours at 80°-90° C.; take from bath and wash.

Second Bath: Algarrobin, 15 per cent. Soak from 1 to 1½ hours at 80°-90° C.; the shade thus obtained is a very dark brown.

Third Bath: Sulfate of iron, 3 per cent.; sulfate of copper, 1 per cent. Soak for one hour at 80°-90° C. Then wash in 0.5 per cent. soap solution at 60° and dry. A weak chloride bath intensifies the perfect black obtained.

For greys the same process is recommended, varying only the percentage of algarrobin. In Havana brown, by varying the percentage in the composition of the mordants, very pretty shades are obtained.

For silk and for animal fiber the process is the same as for wool.

The Coloring Material of Rice Leaves.

M. S. Kumagiri, of the Japanese Department of Agriculture, has succeeded in obtaining a deep purple dyestuff from the leaves or grass of the rice plant by subjecting the material to a special chemical treatment. Like litmus the new coloring material is affected by acids and is changed to a red. It is used successfully in analytical operations, and also for direct dyeing. As the leaves must be gathered before the rice is harvested, it is doubtful if the discovery is of much practical value.

The Use of Bacteria in the Preparation of Natural Indigo

We have had occasion to refer to the promising work now in progress in India, to establish upon a genuine scientific basis the treatment of the indigo plant, for the transformation of the indican present into indigo. The advance thus far made by those in charge of this important investigation, Mr. Hutchinson, the bacteriologist and Mr. Davies, the chemist, is outlined in a recent bulletin of the Pusa Research Institute, and is here briefly summarized:

The possibility of bacterial action was suggested by three facts. Firstly, the gas produced during the process of fermentation in the steeping vat varies in quantity and composition; secondly, chemical decomposition commences near the walls of the vat, and then spreads inwards, this suggesting that the presence of bacteria on the walls has something to do with the change; and, thirdly, there is a curious divergence in the yield, not only between different factories, but between vats of the same factory worked under apparently identical conditions, and in particular, when a new vat is brought into use it takes some days for it to reach the normal yield of the factory.

These observations suggested that the theory of transformation so far accepted, by which the main credit for the change was given to a constituent in the plant itself, was incomplete. The conversion of indican, the crude form of the dye, into indoxyl—which is subsequently converted into indigo by oxidation—appeared to depend in part on outside agencies, and laboratory researches showed this to be the case. It has now been established that bacterial action plays a considerable part in the process of change, being in fact essential to the extraction of the maximum yield of indigo. This is a discovery of great potential importance, for it at once supplies an explanation of, and promises a remedy to, the extraordinary differences in yield which occur in adjacent factories. In Bihar, for example, the variations are from one to several hundred per cent., and no satisfactory reason for their occurrence was previously advanced. It now appears to be certain that the high-yielding vats are equipped with a full stock of beneficial bacteria, while the low yielders are either inadequately stocked with these or contain actively hostile bacteria. Mr. Hutchinson has isolated the adverse bacteria, and also obtained pure cultures of several of the beneficent species, obtaining exact measurements of their indoxyl-producing powers. They exhibit considerable variation.

The introduction and propagation of friendly species can be effected in several ways. The steeping vats can be inoculated with pure cultures, or the multiplication of the beneficial organisms already present can be fostered by the provision of conditions favourable to their growth. Mr. Hutchinson believes that a combination of these two methods will prove the most satisfactory. At the same time the bacteria must be given fuller scope for their action. Being restricted to the walls and floor of the vat, their area of operations is limited, and if the vats are too large their productive powers fail to act on the more remote portions of the indican solution. It therefore appears desirable to adapt the vats so as to increase the ratio of wall surface to cubic contents. What the most efficient ratio is has still to be determined, but this is mainly a matter of experiment. It will certainly vary from factory to factory until the bacterial conditions are uniform. Again, the character of the wall surface is a factor of importance. A smooth cement wall is probably not the ideal surface, in which case a substitute has to be found. This also should soon be revealed by experiment. Once discovered, the practical benefits would be considerable, and quickly repay the producers for the necessary alterations.

A Foaming Process for Treating Textiles

Dr. René Clavel, of Basel, Switzerland, (Amer. Pat. 1,234,732, of July 31, 1917) describes a new process for treating textiles, such as silk, cotton or wool, either raw or finished, with foam. In earlier methods the foam was produced by boiling solutions of materials adapted to foam and aiding hereby, if desired, the conversion of the solutions into foam by injecting into the solutions air under pressure and in a state of fine division. More recently attempts have been made to work at lower temperatures by producing the foam under diminished atmospheric pressure, so that delicate textiles, particularly silk, might be successfully treated.

The processes, therefore, depend upon a supply of heat or steam or upon the action of a vacuum. The high temperature requires rapid working and the vacuum requires closed vessels.

By the present invention the production of foam is quite independent of the temperature of the foam bath, so that textiles which are sensitive to heat can be treated. The foam is produced by the introduction into the solution or liquid, of air, oxygen or other oxidizing, reducing or indifferent gases, under pressure, through finely porous bodies such as tubes or plates of unglazed earthenware, graphite or the like.

The method appears to be applicable with advantage in degumming and weighing silk, in degreasing and cleaning wool, and in numerous operations of dyeing, soaping, degreasing, fixing, mordanting, vat dyeing or developing dyes at any desired temperature.

Dye Extract Works in Jamaica.

Several local establishments in Kingston, Jamaica, for the production of logwood and similar extracts of dyewoods have been acquired by an American company, the United Dye Works Corporation, of which Joseph Baldwin, Jr., is president.

Dyeing by Means of Nitrous Acid and Metallic Salts

John Chester, of Saltaire, Eng. (Amer. Pat. 1,231,492, of June 26, 1917), has devised an improved process for dyeing wool and other animal substances by the use of nitrous acid and metallic salts. He claims to produce permanent colors on the materials in question by combining the substances producing the nitrous acid and the metallic salt in a single bath and by using the bath at a high temperature.

The following is an illustrative example:

Wool is treated in a bath composed of:

Sodium nitrite, 5% of the weight of the material to be dyed,

Commercial sulfuric acid, 5%,

Sodium bichromate, 2%, the whole being dissolved in a suitable quantity of water. The material is put into the bath when the latter is cold. The bath is gradually brought to the boiling point. In this case a brown color is produced. Sodium nitrite and sulfuric acid interact to form the necessary nitrous acid, as in all such operations.

A variation in the metallic salt causes a variation in the color produced. For instance, if copper sulfate be used instead of sodium bichromate, a brown, more reddish in character is produced.

It is claimed that dyeings effected in this manner are far more permanent than when the materials are first treated in a cold, nitrous acid bath and subsequently introduced into a bath containing a metallic salt.

Divi-Divi Extract.

A consular report states that Señor Antonio J. Salinas, holder of an exclusive privilege for the manufacture of tanning and dyeing extracts in Venezuela, has formed a company under the name of Salinas & Modiano for the extraction of tannic acid from the fruit of the divi-divi plant and its preparation in the form of powder or tablets. The company is located at Porlamar, Margarita. The process used is the invention of Señor Salinas. It is claimed that the tablets contain an average of 80 per cent of tannic acid.

The bulkiness of divi-divi relative to its actual value to the dyer and tanner has always caused freight to constitute the greater part of its delivery price. In times of tonnage scarcity this fact has rendered its exportation almost impossible.

Apparatus for Dyeing.

In a recent patent John H. Milner, of Huddersfield, Eng. (Amer. Pat. 1,230,198, of June 19, 1917), describes a new type of dyeing machine, applicable also for various processes of washing textiles. It utilizes the ordinary construction of upper and lower compartments, intermediate perforated plate, central circulating tube and steam supply main. In addition it combines an additional pipe adapted to introduce an auxiliary supply of air into the lower compartment, and to pass this upward, through the perforated plate, for the purpose of lifting the material to be dyed. The air supply is controlled by a steam-operated air injector having a branch connection from the steam supply main. The air supply and the ordinary steam supply can be operated separately or concurrently.

Natural Colors.

The following articles are of value to those especially interested in natural colors:

Note on the Coloring Matter of Red Torulae, A. Chaston Chapman, Chem. News, 1917, *115*, 135. The color is compared with carotin by spectrographic method, and is found not to be the same.

Detection of Catechu in Black Silk Dyeings, P. Weyrich, Faerb. Ztg., 1915, *26*, 317; J. S. C. I., 1916, *35*, 630.

The Dyeing Values of Some Indigenous (Indian) Dyestuffs, J. P. Srivastava, Agr. J. India (Special Indian Sci. Cong. No.), 1916, 53.

The Coloring Matter of Cane Juices, M. A. Schneller, La. Exp. Sta. Bull. No. 157, 1916.

Chlorophyll, G. Cusmano, Ann. Chim. Appl. (Rome), 1916, *5*, 97. A general review of the work on chlorophyll.

Toxicity of Carotin.

H. G. Wells and O. F. Hedenburg (J. Biol. Ch., 1916, *27*, 213) show that carotin is almost devoid of toxicity. Pigment carotin was prepared from fresh carrots and intraperitoneal and intradermic injections of an olive oil solution of the color were administered to guinea pigs, the larger doses being as much as would be contained in 200 kg. of flour.

Increased Cultivation of Indigo in Central America.

There is a notable increase in the area of land now devoted to the production of indigo in the Republic of Honduras. At the close of 1916 there were 1,088 tracts of land devoted to the cultivation of indigo in the Department of Intibuca alone. The total yield is estimated at 30,578 pounds. A marked increase in the cultivation of indigo is likewise reported from most of the frontier bordering on the Republic of San Salvador.

Hitherto Guatemala and especially San Salvador have been the chief sources of indigo in Central America. During the fiscal year 1916 the United States imported 85,000 pounds from San Salvador.

Climatic conditions in this region and also in southern Mexico are exceptionally favorable for the successful cultivation of the indigo plant. With helpful and favoring action on the part of the various governments the production of the natural dyestuff might become a much more valuable agricultural asset of Central America than has hitherto been the case.

MISCELLANEOUS

Outlook for the British Chemical Industry

By Prof. H. E. Armstrong

[The expansion of our American chemical industry in general, and especially of our coal-tar chemical industry, is following lines closely parallel to those along which the British industry is moving. The obstacles to be overcome are mainly the same in both lands. Those laboring in the United States, to liberate us from any dependence, in the future, on German colors and drugs, will find abundant food for reflection and suggestion in the following vigorour portrayal of the British chemical outlook, recently contributed to the London Times by Professor H. E. Armstrong, who stands in the forefront of English chemists, and is constantly consulted by the Imperial authorities on chemical problems of national importance.—Ed.]

One of the most striking results of the war is the advance of the chemist into public favor. Before it, he was scarce considered except as the drug dispenser, though there was a vague idea abroad, and a very wrong one, that he was a person who could analyse and find out of what anything put into his hands was made; in fact, he was either thought nothing of or his powers were vastly overrated. The first thing to be done when the war is over will be to give him the status he has won: by Act of Parliament to recognize that he alone has the right to be called chemist, so that he may be distinguished from the pharmacist.

A recent French writer on the wonderful development of the German chemical industry, particularly in connection with the production of materials required for the manufacture of explosives, speaks of the chemist as having saved Germany. At the outbreak of war her chemical factories were so fully organized that she was able, if not to make all that was required, at once to take the necessary developments in hand.

After the Marne, very large Government subsidies were forthcoming to aid the extension of factories for the production of ammonia and nitric acid, the basic substances of the high explosives industry, by purely artificial processes. The figures given of the outputs achieved approach the fabulous. Deprived as she has been of raw materials, the manner in which Germany has mastered the difficulties is very wonderful. When, if ever, the story is fully told, it will probably be the most astonishing revelation conceivable of the power that man has achieved through science—both for evil and for good. When viewed in proper historical perspective, it must afford lessons of a development of man's command over Nature which will be altogether amazing in extent and variety.

But if the chemists—associated necessarily with the engineers—have saved Germany, in the sense of enabling her to wreak her foul purpose upon those whom she has made her foes, the latter, in turn, have been able to make use of their services in their defence and in a far higher degree. Our advance within a couple of years is comparable almost, it has been said, with that made by Germany during 40 years. We had made scarcely any preparation, and yet it is now admitted that, in not a few respects, we are in advance of her. It may well be imagined that one of her greatest regrets will be that she has made us realize what we can do if forced into action. We were quietly asleep in the mountains, and had matters remained as they were, we should have awakened only to find her in possession of the fertile plains.

Though not an "organizable" people, we have a far greater innate gift of organizing than the Germans. Under compulsion, we have at last allowed ourselves to be organized. The conservatism, which in ordinary times has made us chary of adventure, and checked experiment, has necessarily been waved aside, though not always with the requisite promptness. Even now we lack outlook and a saving grace of modesty. As shown most clearly in the recent Dardanelles report, we still fight shy of the expert, and our self-appointed, would-be leaders too often are the last to appreciate their inability to grapple with the problems they are called upon to solve. The country suffers most, perhaps, from inability to appreciate its ignorance and its consequent impotence to face the complex issues of our modern civilization with understanding. This is our most vulnerable spot, one that ultimate success may lead us still to overlook.

The question of questions concerning our future is whether we shall have learned our lesson sufficiently not to return to our old slothful, ignorant ways, especially whether we shall be willing to work together. The augurs seem to speak hopefully, though they warn us against any slackening of effort.

Agriculture.

To refer first to our chief chemical industry. It is recognized that the greatest of all the world's industries is agriculture, especially if it be held to include forestry, yet few realize that agriculture is, in large measure, a chemical industry of a quite special character and one which presents altogether peculiar difficulties, concerned as it is with the processes of life. No one who has not a very thorough and broad knowledge of chemistry can have real feeling with regard to the problems of modern agriculture; though the phenomena to be interpreted are in no way exclusively chemical, chemical principles are everywhere in operation.

Of all Government Departments, the Board of Agriculture hitherto has been one of the least venturous, perhaps the most difficult to move. It has lacked ideas and ideals, largely through inability to grasp and understand the technical problems of the industry. It has mainly served administrative ends.

In these circumstances, the recent appointment of Mr. A. D. Hall as chief permanent official of the Board, must rank as a step of high importance. It is the first time, apparently, that an actual scientific expert, a Fellow of the Royal Society, through the force of his work, has been appointed to such an office, without reference to Civil Service or political considerations, solely in the interests of efficiency.

Manufacturing Industry.

Turning to manufactures, the future of the chemical industry is intimately bound up with that of British industry as a whole, in particular that of the great textile trade, which is not only dependent upon dyestuffs but is also the chief consumer of so-called heavy chemicals—of alkali, of soap, of acids, and of bleaching powder. The prosperity of the industry can be the consequence only of a general industrial prosperity.

The success of the chemical industry will depend upon the development of economical methods in every branch of its work. The disastrous internecine competition of the past must be eliminated and for it must be substituted an effective co-operation; not only must the highest technical efficiency be secured through wise and generous management, but the ever-present need for continued development must be kept constantly in mind.

It is beyond question that we shall be called upon to face highly organized competition from every quarter—Germany has made the whole world live once more. This can only be met by an equal, if not a superior, degree of technical organization on our part. Whether traders shall be assisted by any protective system is not a suitable subject for this article, nor one with which the writer can deal; yet it is impossible to overlook the fact that, in many quarters, the view prevails that the necessary development cannot be secured without State assistance, at least during the early stages.

Although certain special branches have been highly prosperous, it is beyond question that the chemical industry has languished in this country largely because it has been in a disorganized condition; many reasons have been assigned to explain the failure, but it is clear, particularly if the cases of success be analyzed, that they are all included in this general statement.

Using the term in the broad sense in which the engineering or textile industries are referred to, it is hardly possible to speak of the existence of a chemical industry. The industry has never been in a position to represent its requirements and views in any collective form—a political demonstration such as the textile industry has made recently is inconceivable.

The war has played the part of the fairy prince in leading us to recognize Cinderella's virtue. For the first time, chemical industry is regarded as of national importance—as a primary factor of national safety.

Union or Disaster.

But it must none the less work out its own salvation from within—it must develop ideals and ideas—it must become progressive; above all, it must present a united front. The chemical industry has too long suffered from the inability of firms to work together for any common end. It cannot be insisted too strongly that unless the tendency can be overcome, which so unhappily exists in this country, of regarding all matters from a purely personal point of view, of allowing entirely personal proclivities and considerations, likes and dislikes, and jealousies, to prevail, there can be no success in the future. The recent formation of an Association of Chemical Manufacturers is therefore a step of outstanding importance.

It is to be hoped that ere long the new Association will be able to work in effective conjunction with the Society of Chemical Industry, and that the two bodies will develop complementary activities. The Society has failed hitherto to exert any real influence on chemical industry, and it has been far too much under academic control. But it has never been supported in any proper way by the higher industrial element, one chief reason being that this element itself was without corporate existence and often too narrowly commercialized to appreciate even its own requirements. The coming expansion of the industry must carry with it recognition of the value of science and automatically determine the development of the Society's activity and sphere of usefulness.

But a far more extensive organization of the forces of chemical science must be brought about in the near future if these are to be utilized with effect in the service of the nation. A multitude of special societies now exist representative of a variety of special interests, but largely composed of the same men. The system is wasteful in every respect. It neither serves to promote fellowship nor to encourage breadth of outlook. On the contrary, it is a direct incentive to an undesirable degree of specialization; it only ministers to our very human tendency to form cliques within each of which a set of men can assume importance. We must hope that we shall have learned sufficient wisdom through the war to bring all agencies together which can contribute to the development of chemistry either as an abstract science or in its technical applications.

The Day of the Expert.

Complete organization combined with breadth of outlook in every direction are the essential conditions of future success. Sound finance, a bold and conciliatory sales policy, intelligent buying on a large scale, first-class commercial representation, are all requirements of fundamental importance, which are more or less commonly recognized. But of equal importance, though too often neglected, are the works requirements: the need of a staff of special efficiency ,including an adequate research department, not forgetting also the labor element. Success necessarily involves a progressive outlook. In these days, to stand still is to go back. In future, the technical man must be given a real voice in the commercial control of the works. Our failure to recognize this need is more than anything else perhaps at the root of the errors of the past. Chemistry as a science, and the problems of manufacturing chemistry in particular, demand for their understanding a point of view, a mental attitude and an experience which are foreign to the community at large, and cannot, as a rule, be acquired by commercial men; but it is well within the mental grasp of the man trained to understand scientific problems also to appreciate the problems which the commercial and industrial control of works presents. The main cause of the phenomenal success of German chemical industry has been the admission of the technical experts to a full share in the management; chemist, commercial man, and engineer have been treated alike and given co-ordinate rank. Such must be the case here, if we are to succeed.

The larger firms are already alive to the value of co-operation, but this is in no way recognized at present by the smaller. If wasteful internal competition in the manufacture of substances of which but limited quantities are required should continue, it is clear that no form of protection will enable makers to meet the competition of foreign manufacturers operating on a much larger scale with more perfect plant. Charges for labor and establishment make up so great a proportion of the cost that the manufacture of, say, four times the quantity of an article may have the effect of reducing cost to one-half or even less, in which case a 100 per cent. tariff would be the least that would be effective. The salts of bismuth may be taken as an illustration. Although largely used in medicine, the quantity required in this country is well under two tons per week, a quantity which could easily be manufactured in one small works. In point of fact, the manufacture is now distributed over a considerable number of works, perhaps 10. If only a single works were in operation it would be possible to cut down the supervising staff, the analytical work, and the cost of maintaining plant, labor-saving devices would be worth introducing which cannot now come under consideration, by-products might be utilized, and much waste prevented by proper association of the work with other branches of industry.

Only a large firm can afford the expense of a competent research staff and of the many specialists required under modern conditions. Savings of a fraction of a penny per pound, which seem of no importance to the small man, mean many thousands to his competitor who makes on the large scale. It cannot be economy for 40 firms each to make 40 products at 40 different works—but such has been our method. In some way they must combine to close the older works and specialize by small firms making only a few products at the remainder.

Much more than is commonly supposed has been done here to manufacture the more valuable chemicals; alkaloids, for example, such as atropine, emetine, etc. But in future some more definite national policy must be developed if the industry is to be maintained and enlarged.

Supplies of Drugs.

Better control of raw materials could be secured by co-operation among buyers, as well as by assistance from Government and Consular agents and Government Departments generally.

What the Dutch have done in Java with respect to supplies of cocoa leaves for the production of cocaine and cinchona bark for the production of quinine, England might do in her various colonies and so provide most, if not all, of the raw materials that are required, though we must take care that foreign competitors do not corner these.

When in Java in the autumn of 1914, at the wonderful botanic garden at Buitzenzorg, and elsewhere in the island, the writer had full opportunity of appreciating Dutch economic organization and of contrasting it with our own half-hearted unsystematic measures in the East. But we have made a great advance in the interval.

India has long since met her own needs in quinine. The writer can testify from his inspection of the factory near Darjeeling that the manufacture is carried on in a most efficient manner; the plantations are now becoming so extended that, at no distant date, it should be possible to produce in India all the quinine that is required by the Empire.

The opium produced in India was long regarded as unsuitable for pharmaceutical purposes and very little of it was used, but it is now being exclusively used by manufacturers for the production of morphine. It is true it is inferior to the Turkish and Persian varieties in the amount it contains of this alkaloid, but work is now being carried on to produce an improved material, and there can be little doubt that success will be secured, such is the control we now have of problems of the kind.

Vigorous action is also being taken, under the auspices of the Government of India, to promote a resuscitation of the natural Indigo industry, and there is good reason to believe that this will be possible, if complete cooperation can be secured of all who are concerned. Not a few other illustrations could be given.

There are not a few successful firms in the country as completely organized as any to be met with on the Continent, and these have quietly done their work in the past without particular advertisement. It is recognized, however, that a much wider field has now to be covered, and that, in particular, those branches must be developed in which we were at such a disadvantage. But a new spirit is alive in the country. Great developments have been brought about under the exigencies of war, as those of us who have been privileged to see the new works erected of late can testify. The value of experiment is now understood in a way that it never was before. It is realized that if you are forced to meet a situation and know what you want to do, it is usually possible to effect your purpose; and the value of ideas and of opportunity to test ideas in practice is at last recognized.

The great want of industry in future will be skilled men and gentlemen. It must attract to its ranks on the technical side—the men of business aptitude will take their place naturally—the best type of university graduate. The literary professions and the civil service must no longer have the monopoly of the best brains. The leaders of science must preach the dignity of industry—its value as national service. Now that business men have at last gained admission to the Ministry, it is clear that commerce and industry will secure due recognition at the hands of the nation; some day even science may be considered competent to help.

Progress of the Coal-Tar Chemical Industry in Canada

Not only in the United States, but also in Canada, the movement to attain independence in the production of coal-tar chemicals is gaining increased momentum. According to the Toronto Globe, aspirin, phenacetin and acetic and carbolic acids are being produced and sold as home-made products for home consumption. For the first time moth balls are being manufactured in Toronto. Aspirin, formerly imported from Germany, is produced so successfully that prices, which increased fourfold through the stoppage of German shipments, have been greatly reduced. In 1914 phenacetin sold in Canada for 80c a lb. In 1915 the price soared to $41 a lb., but it is now back to $21. Carbolic acid, which rose to prohibitive prices, has been reduced by discoveries and experience in manufacture. Quotations for salicylic acid are 360 per cent. below extreme war prices. All qualities of acetic acids are now made, and for the first time, glacial acetic acid—99 per cent. pure—has been produced in Canada. before the war at 22c, rose to $4.25, but through man- Later the price was advanced to $12, but it is now down to $6 in consequence of successful home production. Naphthalene rose from 2½c a lb. to 15c, but is now produced in Toronto at 8c. Salicylic acid sold before the war at 22c, rose to $4.25, but through manufacture on this side of the Atlantic, is now obtainable at 80c a lb. It is believed that producers and chemists on this continent who have made heavy expenditure for research and machinery will hold much of the trade they have secured, even against European competition, when peace is restored.

Improved Method of Making Sodium Phenate.

W. Everitt & Co., Ltd., and W. Everitt, of Southall, Middlesex, Eng. (Brit. Pat. 105,612, of 1916) have perfected a process for manufacturing dry, powdered sodium phenate, the details of which are as follows: Equivalent amounts of powdered sodium hydroxide and phenol mixed with 5 per cent. of sodium sulfite are heated at 260° to 280° C. The operation is carried on in a ball-mill under constant agitation. Steam is evolved during the reaction, at the close of which the product is allowed to cool in vacuum. It can easily be removed in the form of a dry powder.

Standards of Colors

The following recent papers are of value to all interested in matching and comparing colors:

Color Standards and Colorimetric Assays, H. V. Arny and C. H. Ring, J. Ind. Eng. Ch., 1916; *8,309;* Oil and Col. Tr. J., 1917, *51,* 1055. The author uses combinations of Co, Fe, Cu, Mn, etc., for color comparisons.

A Numerical Expression for Color as given by the Ives Tint Photometer, O. Kress and G. C. McNaughton, J. Ind. Eng. Ch., 1916, *8,* 711.

Color Matching Unit (A Lamp), St. Louis Brass Mfg. Co., St. Louis, Elect. World, 1917, *69,* 731. This lamp called the "Spectrolyte" uses a 60 watt Mazda lamp. Light rays are modified by reflection, not by transmission.

A New Colorimeter, C. F. Sammet, J. Ind. Eng. Ch., 1916, *8,* 519.

Stereosopic Colors, M. Lukiesch, J. Frank. Inst., 1917, *183,* 773. On viewing colored objects in the same plane as in the projected image of a lantern slide, the different colors do not always appear to be in the same plane. This note describes some preliminary measurements of the magnitude of this stereoscopic effect.

Measuring the Color of Papers, Numerical Expression for Color, Ives Tintometer, O. Kress and G. C. McNaughton, Paper, 1917, *19,* 15.

CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS

CRUDES.

Anthracene, 80 p. c.	lb.	.10	.13
Benzol, pure, water white	gal.	.50	.52
Benzol, 90 p. c.	gal.	.53	.55
Cresol, U. S. P.	lb.	.18	.20
o-Cresol	lb.	.30	.35
Cresylic acid, 95-97 p.c.	gal.	1.10	1.15
Dip oil, 20 p.c.	gal.	.29	.30
Naphthalene, Flake	lb.	.09	.09½
Balls	lb.	.10	.10½
Phenol (carbolic acid), U. S. P., cryst., drs.	lb.	.43	.45
Pitch, various grades	ton	8.00	20.00
Solvent naphtha, water white	gal.	.18	.25
Solvent naphtha, crude, heavy	gal.	.13	.16
Toluol, pure, water white	gal.	1.80	1.90
Toluol, commercial, 90 p.c.	gal.	1.75	1.80
Xylene, pure	gal	1.00	1.25
Xylene, commercial	gal.	.35	.40

INTERMEDIATES AND EXPLOSIVES.

Amido-naphthol-disulfonic acid (H-acid; 1.8.3.6)	lb.	2.75	3.00
Amido-naphthol-sulfonic acid	lb.	—	1.75
p-Amido-phenol	lb.	4.75	5.00
p-Amido-phenol hydrochloride	lb.	5.00	5.50
Amino-azo-benzene	lb.	1.75	1.85
Aniline oil	lb.	.26½	.27
Aniline salts	lb.	.33	.34
Aniline for red	lb.	1.12	1.15
Anthraquinone	lb.	—	—
Benzaldehyde	lb.	5.00	5.50
Oil of bitter almonds	lb.	15.00	16.00
Benzidine	lb.	1.85	1.95
Benzidine sulfate	lb.	1.60	1.65
Benzoic acid	lb.	5.50	8.00
Crude	lb.	3.00	3.50
From gum	lb.	7.25	7.50
Benzylchloride	lb.	2.25	2.50
Chloro-benzene	lb.	,22	.30
Cumidine	lb.	—	—
Diamido-phenol	lb.	9.00	10.00
o-Dianisidine	lb.	—	—
Dichloro-benzene	lb.	.35	.40
o-Dichloro-benzene	lb.	.15	.16
p-Dichloro-benzene	lb.	.21	.24
Diethyl-aniline	lb.	3.00	3.50
Dimethyl-aniline	lb.	.60	.62
Dinitro-benzene	lb.	.33	.35
m-Dinitro-benzene	lb.	.45	.50
Dinitrochloro-benzine	lb.	.50	.56
Dinitro-naphthalene	lb.	.44	.75
Dinitro-phenol	lb.	.58	.63
Dinitro-toluene	lb	.59	.60
Diphenylamine	lb.	.90	1.00
Ethyl aniline	lb	1.00	1.25
Hydroquinone	lb.	2.00	2.10
Hydrazobenzene	lb.	1.50	2.00
Naphthionic acid, white	lb	1.80	1.85
a-Naphthol	lb.	2.25	2.90
b-Naphthol	lb.	.64	.70
Sublimed	lb	.85	.90
a-Naphthylamine	lb	.80	.90
b-Naphthylamine	lb.	1.75	2.00
Sublimed	lb	2.50	3.00
p-Nitraniline	lb.	1.25	1.35
Nitrobenzene	lb.	.20	.22
Oil of Mirbane, ref	lb.	.18	.20
o-Nitrochloro-benzene	lb.	.50	.56
Nitro-naphthalene	lb.	.44	.65
Nitrotoluene	lb	.55	.65
o-Nitrotoluene	lb	.90	1.00
p-Nitrotoluene	lb.	1.50	1.60
m-Phenylene-diamine	lb.	1.15	1.25
p-Phenylene-diamine	lb.	3.50	4.50
Phthalic anhydride	lb.	6.40	6.50
Picric acid, kegs	lb.	.75	1.00
Resorcinol, cryst., U. S. P.	lb.	12.00	13.00
Technical	lb.	6.00	7.00
Salicylic acid, U. S. P.	lb.	.80	.85
Sulfanilic acid	lb.	.34	.35
Tetra-nitro-methyl-aniline	lb.	—	2.50
Tolidine	lb.	3.00	3.50
Toluidine	lb.	.80	.85
o-Toluidine	lb.	.80	.85
p-Toluidine	lb.	2.00	2.10
m-Toluylene-diamine	lb.	1.70	1.75
Xylidine	lb.	.75	.80

SYNTHETIC MEDICINALS, FLAVORS AND PERFUMES.

Acetanilide C. P., bbls.	lb.	.65	.66
Acetphenetidine	lb.	8.00	9.00
Acetyl-salicylic acid, bulk	lb.	—	3.50
Antipyrine, bulk	lb.	22.00	23.00
Bismuth salicylate	lb.	—	3.15
Calcium sulfocarbolate	lb.	1.40	1.45
Ethyl benzoate	lb.	—	8.00
Phenacetin (Bayer)	oz.	—	2.40
Phenolphthalein	lb.	9.50	10.50
Potassium salicylate	lb.	2.90	2.95
Saccharin	lb.	42.00	46.00
Salol	lb.	1.50	1.75
Sodium benzoate, granulated, U. S. P	lb.	1.60	1.70
Sodium salicylate, U. S. P.	lb.	.85	.95
Wintergreen oil synthetic, U. S. P.	lb.	.75	.85
Zinc salicylate	lb.	—	3.25

PHOTOGRAPHIC DEVELOPERS.

Adurol, 16-oz. bottles	ea.	—	10.00
Agfa (intensifier) 2-oz. bottle		—	.40
Amidol, 1-oz. bottle	oz.	.65	.75
Dianol, 1-oz. bottle	oz.	—	.80
Edinol		—	—
Eikonogen	oz.	—	.45
Glycin, 1-oz. bottle	oz.	—	.80
Hydroquinone	lb.	2.00	2.10
Metacarbol		—	—
Metol	oz.	—	—
Monomethyl-p-amido-phenol (identical with metol)	oz.	—	3.50
Nerol (identical with amidol), 1 oz.	oz.	—	.30
Ortol, 1-oz. bottle	oz.	—	.80
Pyrogallic acid, crystals	lb.	2.95	3.15
Rhodol	lb.	—	—
Rodinal, 3-oz. bottle	ea.	—	.75

ARTIFICIAL COLORS.

Acid Black	lb.	1.80	2.50
Acid Blue	lb.	2.50	3.00
Acid Brown	lb.	2.75	3.35
Acid Fuchsine	lb.	7.00	8.00
Acid Green	lb.	3.50	12.00
Acid Orange	lb.	.95	1.25
Acid Orange II	lb	1.25	2.50
Acid Orange III	lb.	1.50	2.00
Acid Red	lb	2.60	2.80
Acid Scarlet	lb.	4.00	4.50
Acid Yellow	lb.	2.00	3.00
Alizarin Blue	lb.	6.75	7.50
Alizarin Blue, bright	lb.	8.50	9.50
Alizarin Blue medium	lb.	7.50	8.50
Alizarin Orange	lb.	6.00	8.50
Alpine Red	lb.	6.50	7.00
Alpine Yellow	lb.	6.50	7.00
Auramine	lb.	4.00	5.00
Aurine	lb.	2.60	3.00
Azo Carmine	lb.	6.50	7.00
Azo Yellow	lb.	4.00	6.00
Azo Yellow, red shade	lb.	4.75	5.50
Bismarck Brown Y	lb.	1.60	2.00
Bismarck Brown FF conc.	lb.	2.00	2.50
Bismarck Brown 3 R	lb.	2.25	3.25
Bismarck Brown R	lb.	1.50	2.00
Bright Red	lb.	3.00	3.75
Shrysamine Yellow	lb.	2.60	3.00
Chrysoidine	lb.	2.10	3.00
Chrysoidine R	lb.	2.25	3.00
Chrysoidine Y	lb.	1.75	2.00
Congo Red	lb.	5.00	6.00
Crystal Violet	lb.	7.50	8.00
Direct Acid Orange	lb.	1.10	1.25
Direct Black	lb.	.90	1.80
Direct Blue	lb.	2.60	3.00
Direct Sky Blue	lb.	5.50	6.50
Direct Brown	lb.	2.80	3.25
Direct Bordeaux	lb.	3.50	4.00
Direct Fast Red	lb.	3.25	4.00
Direct Red	lb.	2.75	3.50
Direct Yellow	lb.	2.50	3.50
Direct Fast Yellow	lb.	3.00	4.00
Direct Violet	lb.	3.50	4.00
Eosin	lb.	10.00	15.00
Fast Red, 6B extra	lb.	4.50	5.00
T extra	lb.	—	2.00
Fast Scarlet	lb.	1.75	2.35
Fuchsine	lb.	7.50	12.00
Fur Black, extra	lb.	2.50	3.00
Fur Brown B.	lb.	3.00	4.00
Fur Brown GG	lb.	4.50	5.00
Green Crystals	lb.	12.00	14.00
Indigo 20 p.c. paste	lb.	1.80	2.00
Indigotin	lb.	2.50	3.50
Induline	lb.	1.90	2.50
Magneta	lb.	8.00	10.00
Malachite Green	lb.	8.50	12.00
Metanil Yellow	lb.	2.50	3.00
Medium Green	lb.	5.00	6.00
Methylene Blue, tech.	lb.	3.00	4.00
Methyl Violet	lb.	3.50	4.00
Naphthol Green	lb.	3.50	4.50
Nigrosine, oil sol.	lb.	1.00	1.50
Nigrosine, sp. sol.	lb.	.90	1.00
Nigrosine water sol., blue	lb.	1.00	2.00
Jet	lb.	1.25	2.00
Naphthylamine Red	lb.	6.50	7.00
Oil Black	lb.	1.80	2.10
Oil Green	lb	2.00	3.00
Oil Orange	lb.	2.00	2.50
Oil Scarlet	lb	2.00	2.50
Oil Yellow	lb.	1.80	2.50
Orange RG	lb.	2.00	2.25
Orange Y, conc.	lb.	1.10	1.50
Ponceau	lb.	3.00	4.00
Quinoline Yellow	lb.	5.00	11.00
Rhodamine	lb.	5.00	6.00
Saffranine	lb.	15.00	20.00
Scarlet 2 R	lb.	5.50	6.00
Soluble Blue	lb	15.00	18.00
Sulfur Black	lb	.75	1.00
Sulfur Black 150 p.c.	lb	1.50	2.25
Sulfur Blue	lb.	2.60	3.25
Sulfur Blue Black	lb	2.00	3.00
Sulfur Brown	lb.	.50	.60
Sulfur Green	lb.	2.00	3.00
Sulfur Yellow	lb.	1.60	2.25
Tartrazine	lb.	1.50	2.00
Wool Orange	lb.	2.25	3.25
Victoria Blue	lb	15.00	22.00
Victoria Blue, base	lb	17.00	20.00
Victoria Green	lb.	14.00	16.00
Victoria Red	lb.	9.00	12.50
Victoria Yellow	lb.	8.00	9.00
Yellow for wool	lb.	3.00	4.50

NATURAL DYESTUFFS.

Article	Unit	Price
Annatto, fine	lb.	.33 — .34
Seed	lb.	.11 — .14½
Carmine No. 40	lb.	4.25 — 4.75
Cochineal, Teneriffe, Silver	lb.	.52 — .60
Gray	lb.	.62 — .63
Indigo, Bengal	lb.	3.75 — 4.40
Oudes	lb.	3.00 — 3.25
Guatemala	lb.	3.00 — 3.25
Kurpahs	lb.	3.50 — 3.60
Madras	lb.	1.40 — 1.45
Madder, Dutch	lb.	.26 — .30
Nutgalls, blue Aleppo	lb.	— — —
Chinese	lb.	.30 — .32
Persian Berries	lb.	— — —
Turmeric, Madras	lb.	.08¾— .09½
Aleppey	lb.	.10 — .11
China	lb.	.07 — .07½

DYEWOODS AND RAW MATERIALS.

Article	Unit	Price
Algarobilla	ton	140.00 —150.00
Barwood	lb.	.06 — .08
Camwood, chips	lb.	.17 — .20
Divi-Divi	ton	65.00 —70.00
Fustic, sticks	ton	50.00 —58.00
Chips	lb.	.06½— .07½
Hypernic chips	lb.	.07 — .08
Logwood, sticks	ton	37.00 —43.00
Chips	lb.	.02¾— .03¼
Myrobolans	ton	64.00 —65.00
Quercitron Bark No. 1	ton	28.00 —31.00
No. 2	ton	20.00 —25.00
Red Saunders, chips	lb.	.12 — .14
Sumac, Sicily, 29 p.c. tannin	ton	87.00 —90.00
Virginia, 25 p.c. tannin	ton	50.00 —59.00

EXTRACTS.

Article	Unit	Price
Archil, double	lb.	.15 — .17
Triple	lb.	.18 — .20
Concentrated	lb.	.21 — .26
Chestnut, 25 p.c. tannin	lb.	.02¼— .02¾
Clarified, 25 p.c tannin	lb.	.02½— .03
Cutch, Rangoon, boxes	lb.	.12 — .13
Liquid	lb	.08½— .09
Tablet	lb.	.10 — .12
Cudbear, French	lb.	.70 — .80
English	lb.	.30 — .32
Concentrated	lb.	.75 — .85
Flavine	lb.	1.25 — 1.50
Fustic	lb.	.13 — .16
Gall	lb.	.18 — .21
Gambier, 25 p.c. tannin	lb.	.10 — .10½
Common	lb.	.16 — .16½
Cubes, No. 1	lb.	.22½— .23
No. 2	lb.	.21 — .22½
Hematine	lb.	.09 — .10
Crystals	lb.	.24 — .34
Hypernic, liquid	lb.	— — —
Indigo, natural, for cotton	lb.	.50 — .54
For wool	lb.	.30 — .32
Indigotin, 100 p.c. pure	lb.	— — 5.50
Logwood, solid	lb.	.20 — .22
Crystals	lb.	.20 — .26
51° Tw.	lb.	.10 — .15
Myrabolans, 25 p.c. tannin	lb.	.06 — .07
Solid, 50 p.c. tannin	lb.	.10 — .11
Osage Orange—		
Powdered, Aurantine	lb.	— — .25
Paste	lb.	.06 — .12
Persian Berries	lb.	.20 — .25
Quercitron	lb.	.05 — .06
Sumac, liquid, 25 p.c. tan	lb.	.05 — .13½

DYEING ACCESSORIES.

Article	Unit	Price
Acetic acid, 28 p.c	lb.	.06½— .07½
56 p.c.	lb.	.12½— .13
Glacial, 99 p.c	lb.	.36 — .37
Albumen, Egg	lb.	1.05 — 1.10
Blood, imported	lb.	.58 — .61
Domestic	lb.	.53 — .54
Alum, ammonium, lump	lb.	.04½— .05
Alum, chrome	lb.	.19 — .22
Alum, potassium, lump	lb.	.09 — .09½
Aluminum acetate	lb.	.95 — 1.00
Aluminum chloride, liq	lb.	.04½— .05
Aluminum sulfate, techn	lb.	.02 — .02¼
Aluminum sulfate, iron free	lb.	.03¼— .03½
Ammonium vanadate	lb.	7.00 — —
Bleaching powder, 35 p.c	lb.	.02¼— .03
Borax, cryst.	lb.	.07¼— .07½
Citric acid, crystals	lb.	.72 — .72½
Powdered	lb.	.72½— .73
Copper subacetate (verdigris)	lb.	.40 — .42
Copper sulfate (blue vitriol), 99 p.c.	lb.	.09¼— .09½
Dextrine, corn	100 lbs.	— — 5.90
Dextrine, imported potato	lb.	.13 — .14
Dextrine, domestic potato	lb.	.09 — .10
Ferric sulfate, basic (nitrate of iron), comm	lb.	.01¾— .02¼
True	lb.	.07½— .08
Ferrous sulfate (copperas)	100 lb.	1.00 — 1.50
Formic acid, 75 p.c	lb.	.40 — .45
Glauber's salt (sodium sulfate)	100 lb.	.70 — .75
Glycerin, C. P	lb.	.69 — .70
Gum arabic, firsts	lb.	.52 — .55
Seconds	lb.	.48 — .50
Sorts, amber	lb.	.33 — .35
White	lb.	.46 — .50
Gum tragacanth, Alep., firsts	lb.	2.25— 2.35
Seconds	lb.	1.95 — 2.05
Thirds	lb.	1.65 — 1.80
Sorts	lb.	.75 — .90
Hydrochloric acid (muriatic)		
18°	lb.	.02¾— —
20°	lb.	.03 — —
22°	lb.	.03¼— —
Lactic acid, 22°	lb.	.05½— .06¼
44°	lb.	.16 — —
Nitric acid, 36°	lb.	.05¾— .06¼
38°	lb.	.06¾— .07¼
40°	lb.	.07½— .07⅝
42°	lb.	.07¾— .08¼
Oxalic acid	lb.	.45 — .48
Potassium antimony tartrate (tartar emetic)	lb.	.59 — .60
U. S. P.	lb.	.62 — .65
Potassium bichromate	lb.	.45 — .46
Potassium ferricyanide (red prussiate)	lb.	2.75 — 2.95
Potassium ferrocyanide (yellow prussiate)	lb.	1.25 — 1.30
Potassium tartrate, acid (cream of tartar)	lb.	.50 — .50½
Prussian blue	lb.	.80 — .90
Soluble	lb.	.95 — 1.00
Sago flour	lb.	.04¾— .05
Soda ash, 58 p.c.	100 lbs.	3.10 — 3.30
Soda, caustic, 76-78 p.c.	100 lbs.	8.10 — 8.25
Sodium acetate	lb.	.11½— .12
Sodium bichromate	lb.	.25 — .26
Sodium bisulfite	lb.	.05¾— .06
Sodium chlorate	lb.	.23 — .24
Sodium ferrocyanide (yellow prussiate)	lb.	.37½— .38
Sodium nitrite techn	lb.	.40 — .43
Sodium phosphate, com	lb.	.04½— .07
Sodium silicate, liquor 40 p.c.,	100 lbs.	1.05 — 1.25
Crystals	lb.	.03¾— —
Sodium sulfide, 60 p.c., fused	lb	.03 — .03¼
Crystals, 30 p.c.	lb.	.02 — .02¼
Sodium thiosulfate (hyposulfite)	100 lbs.	1.75 — 2.00
Soluble oil, 50 p.c.	lb.	.10 — .12
75-85 p.c.	lb.	.18 — .20
Stannous chloride (tin crystals)	lb.	.39 — .39½
Stannic chloride (tin bichloride), 50°	lb.	.19¼— .20
Starch, corn; pearl	100 lbs.	6.30 — 6.48
Potato	lb.	.12½— .13
Rice	lb.	.08— —.10
Wheat	lb.	.05 — .06
Sulfuric acid, 60°	ton	25.00 —27.00
66°	ton	34.00 —35.00
Oleum, 20 p.c.	lb.	.02 — .02¼
Tartaric acid, crystals	lb.	.78½— .81
Turkey Red oil	lb.	.14 — .25
Zinc dust, 350 mesh	lb.	.18 — .25

IMPORTS AND EXPORTS OF COAL-TAR PRODUCTS AND NATURAL DYESTUFFS

The following is the Government report of imports and exports of these wares for the seven months ending July, 1915, 1916, and 1917, and for the month of July, 1916, and 1917.

IMPORTS

ARTICLES	JULY				SEVEN MONTHS ENDING JULY					
	1916		1917		1915		1916		1917	
Coal Tar Products—										
Acid, carbonic lbs.	150,564	$8,771	53,366	$5,106	1,324,844	$74,358	1,468,406	$101,190	315,065	$26,354
Alizarin and alizarin dyes lbs.	32,209	53,856	......	......	3,120,785	823,272	42,369	66,592	7,947	18,220
Aniline salts lbs.	......	......	......	......	245,033	61,705	20	4	......	......
Colors or dyes	......	292,130	......	105,372	......	2,714,261	......	2,895,788	......	1,450,254
Imported from—										
Germany	......	135.464	......	......	......	2,228,916	......	135,589	......	1,449
Switzerland	......	55,020	......	37,647	......	337,937	......	773,204	......	1,089,858
United Kingdom	......	88,476	......	60,181	......	69,077	......	230,672	......	291,870
Other countries	......	13,170	......	7,544	......	78,381	......	1.756,323	......	67,077
Dead or creosote oil gals.	6,919,870	570,296	1,577,009	121,240	20,349,297	1,535.480	31,264.716	2,439,913	8,156,476	647,328
Indigo, natural and synthetic lbs.	275,524	571,592	......	......	3,958,517	1,167,791	3,291,472	5,646,873	......	......
Natural lbs.	......	......	252,253	462,432	......	......	......	......	1,267,651	2,496,489
Synthetic lbs.	......	......	666	329	......	......	......	......	895,310	568,116
Tar and pitch of coal bbls.	2,008	3,626	764	1,220	......	......	15,452	22,959	5,468	8,913
All other coal-tar products, free	......	71,379	......	44,799	......	196,681	......	496,902	......	337,049
dut.	......	62,686	......	13,722	......	273,175	......	418.097	......	157,046
Total coal-tar products	......	1,634,336	......	788,882	......	5,678,472	......	12,088,318	......	5,744,431
Dyewoods, in a crude state—										
Logwood long tons	35,651	1,229,821	4,178	73,899	27,947	396,711	132,885	4,178.378	37,390	1,062,280
All other long tons	2,540	42,442	1.298	32,390	12,555	184,520	12,939	284,030	5.516	122.427
Gambier lbs.	245,000	23,128	1,160,916	74,881	7,043,546	298,606	9,589,980	740,642	6,859,352	618,026

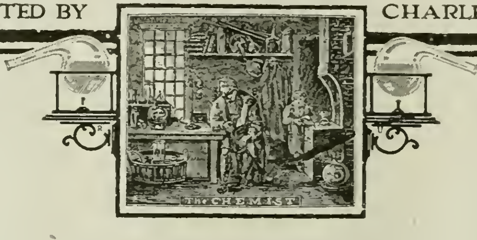
EXPORTS.

ARTICLES	JULY 1916		JULY 1917		1915		1916		1917	
Carbolic acid lbs.	......	......	1,390,523	$726,159	......	......	......	......	......	......
Picric acid lbs.	......	......	2,717,363	1,943,196	......	......	......	......	......	......
Coal-tar distillates—										
Benzol lbs.	......	......	2,978,219	264,458	......	......	......	......	......	......
All other	......	......	......	595,644	......	......	......	......	......	......
Dyes and dyestuffs	......	687,555	......	......	......	$1,270,251	......	4,084,343	......	[2]7,153,689
Aniline dyes	......	......	......	497.106	......	......	......	......	......	[1]497,106
Logwood extract	......	......	......	205 024	......	......	......	......	......	[1]205,024
All other	......	......	......	576,579	......	......	......	......	......	[1]576,579
Total, dyes and dyestuffs	......	687,555	......	1,278,709	......	1,270,251	......	4,084,343	......	8,432,398
Exported to—										
France	......	$30,139	......	$203,691	......	$18,152	......	$237.558	......	$505,784
Italy	......	29 652	......	66,854	......	237,662	......	610,531	......	1,103,900
Russia in Europe	......	56.876	......	......	......	5,922	......	333,994	......	57,683
Spain	......	22,031	......	100,170	......	13,814	......	175,586	......	779,497
United Kingdom	......	128 758	......	363.527	......	439,187	......	483,458	......	1,924,325
Canada	......	135.442	......	80.551	......	347,733	......	1,190 655	......	997,337
Mexico	......	2,689	......	34,729	......	413	......	99,697	......	413,114
Argentina	......	22,695	......	43,610	......	25,400	......	134.457	......	214,941
Brazil	......	30,820	......	152,414	......	3,862	......	95,080	......	954,109
British India	......	......	......	117,608	......	577	......	93,048	......	408,750
Japan	......	27,924	......	36,156	......	98,244	......	132.863	......	416.239
Other countries	......	200,518	......	79,399	......	79,285	......	497,416	......	656,719

[1] Figures cover period beginning July 1. [2] Figures are for six months January to June, inclusive.

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS. F.C.S.



ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

A. W. T. If you desire to reduce the time of exposure in taking your X-Ray photographs, you can do so by using two intensifing screens on either side of your sensitive plate or film, the one nearer the X-Ray tube being of crystalline calcium tungstate, more transparent to X-Ray, and the other one being of the semi-crystalline salt, much less transparent to X-Ray.

I trust this will remove the difficulties you are now experiencing.

F. A. W. The explosive known as "Trinitrotoluol" is a slightly yellow, fine and crystalline powder. You had better forward me a sample of your product so I may submit it to tests in order to ascertain whether or not it comes up to the standard required by the U. S. Navy for a refined Grade "A" material.

L. C. I received the sample of buttermilk and after careful chemical analysis, find it to be a product of Bulgarian bacillus and not the old fashioned buttermilk that has been churned. Real buttermilk is not made artificially, therefore when made from the above bacillus it is a direct violation of the State and National food laws, if sold under the name of buttermilk.

W. W. H. The wine you forwarded last week for analysis has been found to contain artificial coloring matter in the form of an acid, namely, red analin dye. If you fail to mention its presence on the label you will be subjected to a fine.

F. T. S.—The preliminary investigations of your hair tonic and greaseless face cream show them to consist of the following ingredients: Hair tonic—Terebene, sulphur, borax and lavender water. Greaseless face cream—Almond oil, spermaceti, white wax and geranium oil. As requested by you, I am mailing you the complete analysis, giving the exact quantity of each constituent, together with working formulae for their preparation.

C. M.—The solubility of calcium sulphite ($CaSO_3.2H_2O$) in 15% cane sugar solution at 30° C. is 103 mgr. per litre. This amount decreases to 11 mgr. as the temperature is increased to the boiling point of water.

K. L. S.—Your letter together with sample of fumigant has been received and wish to state that its chemical analysis shows it to be Para-Dichloro-Benzene ($C_6H_4Cl_2$).

It possesses a weak ether-like odor, volatile in air and has a melting point of 53.0° C., and a molecular weight of 146.952.

W. A. F.—Regarding the dying of your wool with the coloring matter you have enclosed, I advise you to use the following method:

Sulphuric acid	1.5%
Coloring	3.5%
Glaubers salts	2.0%

Boil together and strain in bath. Start bath at 170°, raise to 190° slowly, wash in warm water.

S. R. D.—As I have mentioned many times in these columns, coal having low calorific or heating value not only clogs the grates and eventually ruins them, but its purchase at even low price is anything but economical. Soft coals having a heating value of 12,000.0 B.T.U. like those you have just forwarded me for analysis are far below the average.

Charles B. Davis.

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail are specifically requested, communications can only be considered in the order of their receipt.—Editor.

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By Carleton Ellis and A. A. Wells.*

This Is the Seventh Installment of an Article Dealing with an Investigation Conducted by the Writers into the Possible Applications of Ultra Violet Light. The Present Paper Continues the Discussion of Various Forms of Apparatus Employed for the Sterilization of Transparent and Opaque Liquids, Emulsions, Municipal Water Supplies, Etc., by Means of Its Rays. Part VIII Will Appear in the Next Issue.

PART VII

Sterilization of Liquids—Continued.

Henri, Helbronner and von Recklinghausen (U. S. Patent 1,091,221, March 24, 1914) describe an apparatus for the sterilization of water and other similar liquids, which consists of a chamber filled with the liquid to be sterilized, in which chamber is located the source of ultra violet rays. Inasmuch as the efficiency of the ultra-violet lamp depends upon the temperature, the lamp itself is surrounded by a containing vessel made of quartz or other similar material which is exhausted to a very high vacuum in order to obviate the absorption of the ultra violet rays by the air which would normally be contained in the enclosing vessel.

An apparatus for treating liquids which are practically transparent to the ultra violet rays has been proposed by Henri, Helbronner and von Recklinghausen (U. S. Patent 1,132,266, March 16, 1915), who use a treating chamber located more or less radially about the lamp and having baffles which radiate toward the lamp, thus producing an apparatus in which there are no shadows. The liquid to be sterilized is passed in at one end of the apparatus and flows back and forth around the baffles, in this manner being agitated and thoroughly exposed to the action of the light.

Centrifugal Apparatus.

In another process for sterilizing liquids such as water, Henri, Helbronner and von Recklinghausen (U. S. Patent 1,140,819, May 25, 1915) describe the use of an apparatus which consists of a cylinder to contain the liquid to be sterilized, through the center of which is passed a rod serving as a support for the ultra violet lamps. The two types of apparatus are indicated, in one of which, the chamber itself is rotated at such a speed that the water therein will be thrown to the sides, thereby forming a hollow space in the center. The lamp or lamps are situated in this central space. This arrangement prevents the cooling of the lamps by contact with the liquid. As the chamber itself is air tight, the vacant space surrounding the lamp would be under somewhat reduced pressure, thus minimizing absorption of ultra violet rays by the air. In the other case, the chamber itself is stationary but a propeller is placed therein which when rotated throws the liquid, undergoing sterilization, to the outside walls. If desired, air or an inert gas may be admitted to the vacant space about the lamp.

Rotary Funnel Apparatus.

A funnel shaped apparatus, also by Henri, Helbronner and von Recklinghausen (U. S. Patents 1,118,006, November 24, 1914, and 1,132,265, March 16, 1915) for sterilizing milk or other liquids. In case the liquid is transparent, such as water, it is passed in a comparatively thick film along the sides of the chamber, which is rapidly rotated. The liquid is admitted at the bottom and the effect of rotation is to cause it to run up the sides and over the top into a suitable receiver. In case the liquid is rather opaque, such as milk or emulsions, the walls of the sterilizing chamber are corrugated. As the container is rotated, the liquid slowly climbs to the top, being spread out in very thin layers as it passes over the corrugations, thus exposing the fluid in an efficient manner to the action of the light. Another modification of the same apparatus consists in passing a vigorous stream of air through the liquid, causing it to be strongly agitated and be thrown up from the surface of the liquid in the form of spray. On account of the extremely fine division of the particles in this spray, sterilization is claimed to be very efficient. The current of air also serves to keep the liquid cool and to remove any ozone which is formed and which in certain instances, such as in the case of milk, would cause a disagreeable flavor. Other modifications, such as spraying water on the outside of the container to reduce the temperature and of inverting the funnel and allowing the liquid to flow on the outside into a receiving vessel are also described. In this latter case, the source of light is located outside of the sterilizing chamber.

In still another apparatus for sterilizing liquids, von Recklinghausen (U. S. Patent 1,193,209, August 1, 1916; J. S. C. I., 1916, 976) proposes the use of a small corrugated chamber located above an ultra violet lamp. The liquid to be sterilized flows down the corrugated walls of the vessel and thus becomes sterilized by the action of the light. Methods of control of operation of the lamp and of the flow of water through the apparatus are given; also a method for automatically emptying the device in case the current should be cut off. The temperature of the operation is controlled by cooling with water.

---

*All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

In apparatus of the type where a mercury vapor lamp, surrounded by a quartz chamber, is immersed in the liquid to be treated, a ball-float or similar device is proposed by Helbronner and von Hecklinghausen (British Patent 4,895, Feb. 27, 1911) so that the operation of the lamp is prevented until the liquid rises to such a level in the tank, in which the sterilizing operation takes place, that the lamp is completely immersed in the liquid. The ball-float may be fitted in a small chamber on the pipe supplying the liquid to the tank containing the lamp.

A form of apparatus in which the lamp emitting the ultra violet rays is suspended above a tank containing the water is also described by Helbronner and von Recklinghausen (British Patent 24,632, Oct. 28, 1912). A helical quartz tube is mounted within the tank with its upper end just below the surface of the water and the lower end passes through the bottom of the tank. The upper layer of water, which is sterilized by the rays, passes into the helical tube and is discharged through a valve at the lower end. When the apparatus has not been used for some time, this valve may be closed for a short time until the tank is filled and the water overflows, carrying with it floating impurities.

Control Devices.

Where the liquid is admitted to the sterilizing chamber through a valve which is operated by an electromagnet in series with the lamp Helbronner and von Recklinghausen (British Patent 21,829, May 1, 1911) suggest the use of an auxilliary valve so that any liquid leaking through the main valve when the latter closes owing to the lamp being extinguished, is conducted directly to a waste pipe and is thus prevented from entering the sterilizing chamber.

Von Recklinghausen (U. S. Patent 1,190,609, July 11, 1916) describes an apparatus for the treatment of large volumes of water for sterilization. The container for the water consists of a large tank or chamber with an ultra violet lamp bent in the shape of a U attached to one side and extending into the interior. The lamp is protected from actual contact with the water by a quartz tube. The necessary electrical appliances, such as switches and rheostats, are enclosed in a receptacle attached to the water container adjacent to the lamp. In case of breakage of the protecting tube, thus allowing the water to escape, means are provided for conveying this water away before it has an opportunity to damage the electrical appliances. A number of modifications of the apparatus are shown.

Helbronner and von Recklinghausen (French Patent 415,842, April 20, 1910) describe several devices for sterilizing liquids which ensure that the liquid under treatment shall present a perfectly smooth surface while it is being subjected to the action of ultra violet rays proceeding from a mercury vapor lamp. This object is attained by passing the liquid, during treatment, through a number of rectangular tubes or around partition plates reaching alternately nearly to the top and bottom of the vessel. Tubes of various sizes may be placed in the vessel in order to equalize the velocities of the different currents in the liquid. The tubes may be inclined, having the inlet ends slightly above the surface of the liquid.

Removing Dissolved Air.

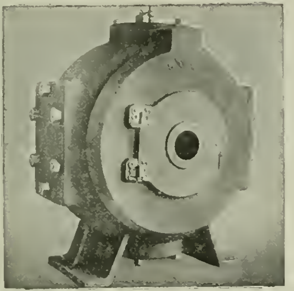
A cylinder provided with a piston for forcing the liquid through the treating vessel is also suggested by Helbronner and von Recklinghausen (British Patent 8,158, of 1911). Compressed air is admitted below the piston so as to cause it to rise to the top of the cylinder, thus allowing the liquid to flow into the part of the cylinder below the piston. When compressed air is admitted above the piston, the liquid is forced out into pipes which conduct it to the treating chambers. Another apparatus for removing dissolved air from the liquid previous to treatment with ultra violet rays is described, which consists of a rotating bell-shaped vessel mounted in a chamber. The liquid is allowed to flow over the outer surface of the vessel while the air is exhausted from the chamber.

Rotary Chamber.

Triquet (J. S. C. I., 1912, 43, U. S. Patent 1,030,692, June 25, 1912) describes an apparatus for sterilizing water which consists of a vessel flanged at both ends and having several flanged openings on the sides. The end flanges are connected to reducing chambers which in turn are connected by means of stuffing boxes to the water inlet and outlet pipes, thus making the sterilizing chamber rotable. The side flanges connect to ducts within the chamber in which are mounted quartz mercury vapor arc lamps, the mercury chambers of which are outside of the sterilizing chamber. In order to tilt the lamps in starting, the whole body of the sterilizing chamber is rotated. The lamp chambers are tightly closed by covers fastened into place with clamps and set screws.

Opaque Liquids.

Von Recklinghausen sterilizes opaque liquids (Chem. Abs. 1916, 649, U. S. Patent 1,165,921, Dec. 28, 1915) by means of an apparatus which exposes the liquid in a thin film, formed by passing the liquid between two plates spaced a short distance apart. The upper plate is composed of quartz or some other ultra violet transparent material. The plates are held in place by thin sheets of tinfoil. The liquid to be sterilized is held in a container located somewhat above the treating chamber, thus causing a constant pressure and therefore a constant flow of liquid through the sterilizing chamber. A device for automatically cutting off the apparatus in case it should become clogged by small particles of material, for example particles of butter, is described. This device operates to ring a bell to warn the attendant or the lamp itself may be cut off. Two modifications are shown by von Recklinghausen, one of which consists of a balance, one end containing a vessel to receive the sterilized material, while in the other end a similar vessel is placed which receives a stream of water having its flow regulated at the same rate as the material from the sterilizer. In case the weight of water exceeds the weight of milk or other liquid undergoing sterilization, a short circuit is formed and either the operator is warned by means of a bell or the lamp is shut off. In another case the receiving vessel is located at such a distance from the outlet from the sterilizing chamber that the stream of liquid will flow from the sterilizer, at a predetermined rate, into the receiving vessel. In case the flow becomes retarded not all of the liquid will enter the receiver. A portion of it will fall upon an inclined electrode having a short gap so that when the liquid flows across this space it will cause a short circuit, thus warning the operator.



Small Pressure Type Sterilizer for Use in Homes, Small Office Buildings, Hotels and Small Manufacturing Plants.

(Courtesy R. U. V. Co., New York.)

Henri, Helbronner and von Recklinghausen (U. S. Patent 1,145,140, July 6, 1915) propose the following form of apparatus for the treatment of deeply colored or opaque liquids or emulsions which normally are rather difficult to sterilize efficiently. The apparatus consists of a series of narrow chambers enclosing an ultra violet lamp; the sides of the chambers facing the light being made of quartz plates. The plates are spaced apart with paper, rubber, etc., thus forming a very narrow chamber through which the liquid flows during the process of sterilization. In one instance these chambers are mounted so that they may be rotated about the source of light, thus exposing all surfaces uniformly. In order to prevent the liquid, undergoing sterilization, from becoming too hot, the series of chambers may be arranged to form the walls of a receptacle, which is filled with water, or a thin film of water may be sprayed over the surface exposed to the action of the light. It is stated that since water is more transparent to ultra violet rays than air, better efficiency is obtained by having the space between the lamp and the sterilizing chamber filled with water than is the case when air has free access.

Automatic Distance Maintaining Device.

In another apparatus of Helbronner and von Recklinghausen (British Patents 28,067, Dec. 1, 1909, and 25,883, Jan. 24, 1910) the source of the ultra violet rays is supported by a float mechanism (floats operating in chembers connected with the main conduit), so that a constant distance between the surface of the liquid and the source of the rays is automatically maintained. The lamp may also be mounted in a closed container fixed in a constant position above the liquid, the surface of which is automatically maintained at a definite level by means of a float valve capable of admitting air either under compression or at atmospheric pressure.

In still another apparatus described by Helbronner and von Recklinghausen (First Addition to French Patent 403,947, June 11, 1909; J. S. C. I., 1910, 107) the lamp which is employed is enclosed in a chamber constructed of material which will transmit ultra violet rays and from which the air is exhausted. This chamber has two widened portions for receiving the ends of the lamp, while its central part is tubular and may be of circular, triangular or hexagonal cross section. The liquid may be treated under pressure by passing it through a tank provided with baffle plates which direct the current of water around the chamber. The lamp employed (First Addition, to French Patent 424,369, March 12, 1910; J. S. C. I., 1911, 978) may also be contained in a chamber shaped so as to receive the wide ends of the lamp, the central portion of the vessel being tubular and capable of transmitting ultra violet rays. This tubular portion may also be of hexagonal or triangular cross-section. The lamp may be located in a tubular chamber fitted in a tank containing partitions which direct the current of liquid below and then above the lamp.

A sterilizing apparatus proposed by von Recklinghausen, Helbronner and Henri (U. S. Patent 1,196,481, Aug. 28, 1916; J. S. C. I., 1916, 1079) consists of a mercury vapor arc lamp which has an enlarged nonluminous portion at one end, containing both electrodes, and a narrow luminous portion which is placed in the side of the sterilizing chamber so that the narrow portion projects into a tube in the chamber while the non-luminous part of the tube remains outside.

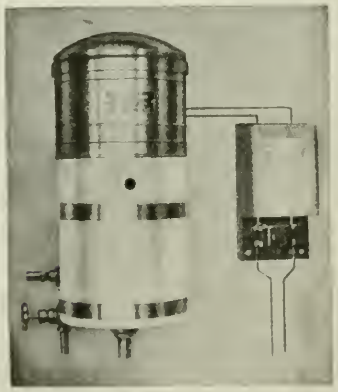
Effect of Shape of Lamp.

It is stated by von Recklinghausen, Helbronner and Henri (U. S. Patent 1,176,481, Aug. 29, 1916) that in a mercury vapor lamp of given dimensions and a constant amount of electrical energy there exists a definite relation between the amount of ultra violet rays produced and the amount of luminous radiation. If, however, any of the above conditions are changed, the ratio between the violet and luminous portions of the radiations will be altered. It is stated that this is probably due somewhat to the temperature of the lamp as the ultra violet rays are increased in a given length of tube as the temperature rises. By constructing the mercury vapor chamber in the form of a U the two electrodes are brought close together and the heat radiations from one help to heat the other, thus raising the amount of ultra violet rays produced in proportion to the current consumed. In the construction of lamps of the U shape, there is a tendency for that portion of the quartz tube at the bend to deteriorate or become opaque due to the fact that in making this bend the center of the tube is not followed. It is proposed to reinforce these U-shaped tubes on the inside of the bend, thereby prolonging their life.

In a form of lamp devised by Helbronner and von Recklinghausen (British Patent 14,129, June 10, 1910) the lamp proper is surrounded by a quartz or silica envelope. The air is completely exhausted from the space between the lamp and the outer tube or envelope so that, when the apparatus is immersed in a liquid, radiation of heat from the lamp is prevented, while the normal working of the lamp is not affected. The wires conducting the current to the lamp pass through the walls of the envelope. In one form, only the straight tube between the two bulbs is surrounded by an outer jacket.

Powerful Source of Ultra Violet Light.

A type of powerful ultra violet lamp described by Helbronner and von Recklinghausen (Comptes. rend., 1912, 155, 852,854) consists of a quart U-tube the sides of which nearly touch one another. The diameter of the tubing is 14 mm. and the length of the sides 160 mm. The two mercury electrodes are side by side. The lamp takes a current of 500 volts, with a difference of potential between the electrodes of 375-390 volts, and with an intensity of 3 amperes. The illuminating power perpendicular to the axis is 8,000 candles. Chemical reactions brought about by ultra violet rays are claimed to be very greatly accelerated by the use of this lamp. For sterilizing large quantities of water the lamp is placed in a cylinder of transparent quartz; this is placed in the center of the sterilizing tank and by a series of baffles the water is made to circulate round the cylinder. In this way the lamp burns as in air, and the utilization of the rays is complete. As to the life of this lamp, Helbronner and von Recklinghausen claim that an installation of 8 amperes has been used 1,200 hours without change, the strength of the rays being tested each day by the rapidity of the blackening of silver citrate paper when exposed to them.



Small Gravity Sterilizer Particularly Applicable to Homes, Laboratories and Small Bottlers.

(Courtesy R. U. V. Co. New York)

Sterilization Investigations by Spencer.

Tests of ultra violet ray apparatus for the sterilization of water have been conducted by Spencer (Engineering and Contracting, 1917, 256).

A gravity and a pressure type of mercury vapor arc lamp apparatus were tested. In the gravity type the lamp is suspended in a baffled treatment chamber a few inches above the surface of the water, which in a thin film is exposed twice during its passage by the lamp. This type is operated at 110 volts and has a rated capacity of 120 gal. per hour.

Gravity Type Apparatus for Swimming Pools, Also Used by Brewers, Bottlers, Ice Manufacturers, Etc.

(Courtesy R. U. V. Co., New York.)

The pressure type consists of a cast iron cylindrical shell with a quartz tube through its axis and containing an arrangement of baffle plates for the same purpose as those in the gravity type. The lamp is inserted within the axial quartz tube. A 220-volt lamp is required to produce a sufficient amount of ultra violet rays for treating 750 gal. of water per hour, the rated capacity.

Usually a fluctuation in voltage of 10 per cent. or over is sufficient to extinguish the light. To prevent the passage of untreated water, each apparatus is provided with an automatic electrical arrangement controlling valves which will prevent the flow of water until the temperature of the lamp has risen sufficiently to produce an abundance of ultra violet rays and which will cut it off when for any reason the light goes out.

Each apparatus was operated in connection with a rapid sand pressure filter which clarified the water just before it entered the light chamber. It was at this point that all the raw water control samples were taken. In order to artificially contaminate the water the alum shunt-feed box on the filter was kept filled with rich broth cultures of B. coli and other bacteria. By this means enormous quantities of all kinds of organisms could be fed to the filter, which allowed nearly all to pass through to the ultra violet ray apparatus after the sand bed had once become thoroughly saturated with them. The raw water contained many more times B. coli than one ever finds in the worst drinking water.

The vast majority of all samples were collected while the apparatus was being operated in excess of its rated capacity.

Small Gravity Type Apparatus.

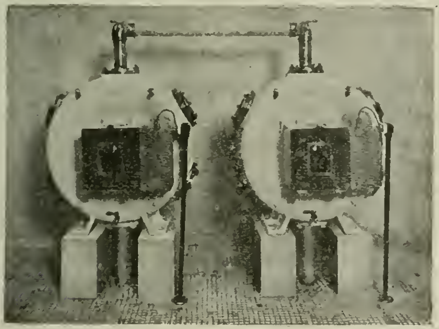
(Capacity, 120 gal. per hour.)

The following table includes a total of 142 samples, taken on seventeen different days during a period of two months:

No. and kind of sample.	Average total count per c.c. on Agar at 37° C.	Average number of B. coli.
33 raw water	29,400	3,256 in 1 c.c.
109 treated water	12	1 B. coli in 15 c.c.

86 of 109 treated samples gave 0 B. coli in 50 c.c.
10 of 109 treated samples gave 1 B. coli in 50 c.c.
2 of 109 treated samples gave 2 B. coli in 50 c.c.
2 of 109 treated samples gave 3 B. coli in 50 c.c.
1 of 109 treated samples gave 4 B. coli in 50 c.c.
1 of 109 treated samples gave 5 B. coli in 50 c.c.
*7 of 109 treated samples gave 50 B. coli in 50 c.c.

*The last seven samples showing 50 B. coli in 50 c.c. were taken after the machine had been idle for one month and the raw water controls at the same time had at least 100,000 B. coli per c.c. and a total count of 150,000. If these seven samples are eliminated in figuring the average number of B. coli in the treated water, there would be only one B. coli in 175 c.c. instead of one in 15 c.c. as shown in the table.



Pressure Type Sterilizer, a Companion to the Large Gravity Type, Which Can Be Used for Any Purpose Where a Fairly Large Capacity of Water Is Required.
(Courtesy R. U. V. Co., New York.)

Large Pressure Type Apparatus.

(Capacity, 750 gal. per hour.)

The following table includes a total of 330 samples, taken on twenty-nine different days during a period of two months:

No. and kind of sample.	Average total count per c.c. on Agar at 37° C.	Average number of B. coli
48 raw water	3,900	3,256 in 1 c.c.
282 treated water	7	1 B. coli in 103 c.c.

211 of 282 treated samples gave 0 B. coli in 50 c.c.
31 of 282 treated samples gave 1 B. coli in 50 c.c.
21 of 282 treated samples gave 2 B. coli in 50 c.c.
14 of 282 treated samples gave 3 B. coli in 50 c.c.
3 of 282 treated samples gave 4 B. coli in 50 c.c.
2 of 282 treated samples gave 5 B. coli in 50 c.c.

The bacteriological tests were performed, with slight exception, in accordance with the Standard Methods of Water Analysis of the American Public Health Association. The fermentation of lactose broth and the characteristic appearance on Endo was considered sufficient identification of B. coli.

A total of 391 treated samples were tested. Of these 53, or 13.5 per cent., did not come within U. S. Treasury Department standard of permissible impurity, which requires that not more than one of five 10 c.c. portion of each sample shall show the presence of organisms of the B. coli group. This appears to be a poor showing. However, it cannot be so considered when a comparison is made with the extremely polluted raw water control samples collected at the same time.

In the gravity type of apparatus 86 of 109 treated samples, or 78.8 per cent., showed no organisms of the B. coli group in 50 c.c., while the untreated water contained an average of 3,256 B. coli per cubic centimeter.

In the pressure type 211 of 282 treated samples, or 74.8 per cent., gave no B. coli in 50 c.c., while the untreated water was yielding 2,630 B. coli in 1 cubic centimeter. The great reduction is the more remarkable when one considers the actual time of exposure of the water to the rays is approximately 64 seconds in the large and 30 seconds in the small apparatus, when they are running at their normal rate.

The fact that spore-bearing organisms are somewhat more resistant to those rays than vegetative forms has been shown by von Recklinghausen. In the above outlined tests the lactose broth tubes would frequently show fermentation at the end of 48 hours. In such cases transfers invariably proved negative on Endo for B. coli. The organism that caused this result proved to be a strict anaerobe and was later identified as belonging to the B. Welchi group. It is believed that the appearance of such organisms in water is not of sanitary significance.

Spencer's Conclusions.

The use of ultra violet rays in the purification of drinking water is relatively a recent procedure, and it is believed that the method is capable of further development, with a corresponding increase in efficiency. The method is especially recommended for treating water in circulating systems, in which the water may be exposed many times to the ultra violet rays. Such systems are now used for disinfecting water in swimming pools, hotels, industrial and other institutions. The chief advantage of this method of treatment over chemical methods lies in the fact that objectionable overdosage is impossible. Again, from the standpoint of potability, the water is absolutely unchanged, and hence in this respect is superior even to boiled water. Recently ultra violet rays have been recommended for sterilizing the drinking water on vessels traversing the Great Lakes. The fresh water of the lakes is very clear, and the turbidity that does occasionally occur consists mostly of heavy suspended matter and is easily removed by filtration.

The present forms of apparatus need considerable attention when in operation. Care should be taken to prevent an accumulation of grease or dirt of any kind on the quartz tube. Experience has shown that a very small amount of grease will obstruct the light sufficiently to allow many organisms to pass. Furthermore, the light chamber should be emptied if the machine remains idle for any length of time. This will prevent the growth of algae and other organisms which will obstruct the light when the machine is operated. There is no way to determine when the lamp fails to emit a sufficient amount of ultra violet rays to give a satisfactory water, except by collecting samples and testing the treated water frequently. Theoretically, as long as the lamp remains intact and the vacuum holds, no reduction in the amount of ultra violet emanation occurs. It is stated by the manufacturers that a lamp will wear out before its efficiency noticeably decreases. The proper construction of the lamp is of great importance, and considerable variations have been noted between individual lamps.

In the above tests, since the gravity type gave a higher efficiency than the pressure type, and inasmuch as any lamp operating at a higher voltage is known to emit a larger amount of ultra violet radiation, the use of lamps at a higher voltage, combined with the gravity system, suggests itself as a reasonable line of development.

In regard to cost, the method is not expensive when treating quantities of water of 30,000 gal. or less per 24 hours. For municipal supplies, using several million gallons per day, the expense is considerable, and probably prohibitive.

(To be continued in the November issue.)

An Investigation of the Wet Thiogen Process

In the last several years, the Bureau of Mines, Department of the Interior, has devoted considerable study to various proposed methods for eliminating or recovering sulphur dioxide from smelter smoke. Among these has been included a critical study of the Wet Thiogen Process. The results of the investigations on this process are given in U. S. Bureau of Mines Bulletin 133, "The Wet Thiogen Process for Recovering Sulphur From Sulphur Dioxide in Smelter Gases," by A. E. Wells.

In carrying out the Thiogen Process the gases are first cooled and cleared of all dust and fumes. They are passed through an absorption tower in which the sulphur dioxide is absorbed in water or mother liquor. To the solution of sulphur dioxide is added powdered barium sulphide, when there is precipitated barium sulphite, thiosulphite and sulphur; the precipitate is settled and the mother liquor is returned to the absorption tower. The settled precipitate is then filtered and dried. The elemental sulphur and one-half the sulphur from the thiosulphite is distilled and the sulphur vapors condensed. The residue, consisting of barium sulphite and sulphate, is then reduced to sulphide, which is returned to the operation as a precipitate.

In the investigations of the Bureau, all the operations involved in the process were studied, both on a laboratory scale, and on a scale that may be considered semi-commercial, and the technical possibilities of the process were determined.

The results of these laboratory investigations indicate that the process can be carried out successfully on a commercial scale. No factors were found which would prevent the successful conduct of any of the operations involved.

However, in the reduction of the barium or sulphite it was found that there is a tendency for the formation of barium oxide and carbonate, which will react very slowly in the precipitation operation. Thus these compounds will increase in amount, as the barium is used repeatedly in the cylic operations. However, the proportion of these insoluble barium compounds can be reduced to a low figure by rapid reduction with pure carbon at a high temperature in a furnace externally heated.

In any case, as the soluble barium compounds increase in the cycles the soluble barium sulphide can be leached out and the insoluble compounds allowed to react with strong sulphur dioxide solution, resulting in their conversion to sulphite or sulphate, which can subsequently be reduced to sulphide.

The conclusions from this work were that in some localities the process can be carried out successfully for the recovery of sulphur dioxide in waste smelter gases on a commercial scale and at a cost of about $12 to $13 per ton of sulphur produced.

The Significance of the National Chemical Exposition

(Concluded from page 295.)

"Dyestuff manufacturers, like all others engaged in undertakings which are primarily expected to be profitable, will naturally tend to produce those commodities which are in the most general demand and in the largest use. Whether our newest addition to the industrial accomplishments of the country continues to live and thrive after the war is over, and when, presumably, we shall meet with the desperate competition of interests which are struggling to save for themselves the remnants of trade life which have been left to them, depends on two things—a proper degree of protection against dumping and undervaluations of imports, and an earnest and patriotic co-operation on the part of our manufacturers and color users themselves."

An entire building, constituting one of the units of the large plant of the Federal Dyestuff and Chemical Co., at Kingsport, Tenn., was destroyed by fire on July 5, the loss being estimated at $30,000. A broken electric bulb caused the fire. No serious delay is caused in the general output of the works.

The Chemical Engineer

A Monthly Journal of Practical, Applied and Analytical Chemistry

INDEX

VOLUME XXV Feb., 1917---Oct., 1917

Subject Index

ACIDS:
  Benzene Sulfonic, *Manufacture of* 258
  Carbolic *and Salicylic in Antiseptic Gauze and Cotton, Determination of* 174
  Chromotropic, *New Azo Dyes from* 298
  2.5.7-Amino-Naphthol-Sulfonic, *New Dyestuffs from* . 175
  Free, *The Estimation of in Solution* 28
  Hydrocyanic, *Manufacturing Tests of Cotton Fumigated With* 104
  Hydrocyanic, *Process for Fumigating Baled Cotton* .. 37
  Nitrous, *Dyeing, by Means of —— and Metallic Salts* 303
  Phosphomolybdic, *Use of in Producing Color Lakes* .. 226
  Picric *and Other Nitrated Phenols, Preparation of* .. 22
  Picric, *Explosions of* 257
  Picric, *from Certain Gums* 141
  Picric, *Quantitative Estimation of* 220
  Picric, *Recovery from Wash Water* 171
  Phthalic, *and Its Anhydride—a New Process for the Production of* 187
  Salicylic *and Carbolic in Antiseptic Gauze and Cotton, Determination of* 174
  Sulfonic, *An Improved Method of Separating* 221
  Sulfonic *from Sulfuric Acid and Their Technical Preparation in a Solid Form, Separation of Aromatic* 171
  Sulfonic, *Manufacture of* 129
  3-nitro-1-amino-benzene-6-sulfonic 220
  Tungstic, *Color Lakes Derived from Complex* 225
Acridine Dyestuffs, *Disinfectants Derived from* 141
Aetna Explosives Co. *Secure Privileges to Fulfil Contract, Receivers of* 127
Algarrobin 301
American Electrochemical Society, *Thirty-first General Meeting* 113
America's *Chemical Progress* 126
Amido-Oxy Compounds, *Aromatic* 221
Ammonium Sulphate *for Japanese, Shortage of* 66
Aniline *Dyes in the United States* 34
Aniline, Dimethyl, Monomethyl, Diphenylamine and Their Homologs, Manufacture of, Reference 174
Annatto *from Porto Rico* 206
Anthracene, *The Manufacture of* 247
Anthraquinone, *Amino-* 221
Antipyretic *Stimulants* 272
Apparatus, *The American Manufacture of Laboratory* 275
Archil *Extract in the United States, The Manufacture of.* 268
Arseno-Phosphorus *Compounds, New* 272
"Aspirin" *Trademark, Interest Aroused in Suit Over* 142
Autumnal Foliage *as a Source of Dye* 270
Azo Colors, *A New Class of Yellow* 224
Azo Colors *for Use on Vegetable Fibres, New* 225
Azo Dyestuffs *Containing Copper, A New Series of Ortho-oxy-* 259
Azo Insoluble Dye, *New* 175
Bacteria *in the Preparation of Natural Indigo, The Use of* 302
Baeyer, *Death of Adolph von* 242
Barium *and Radium to Carbonates, Conversion of* 66
Barks, *Comparative Tests with Mangrove and Wattle* 69
Barrett Co., *Plant, Explosion in* 127
Bayer & Co., *Works at Rensselaer, The* 265
Benzene *and Toluene for High Explosives, Some Sources of* 249
Benzene *Derivatives to Insects, Toxicity of* 174
Benzol *in Gas, Estimation of* 254
Benzol *Plant, New* 273
Benzol *Tests in Coke Works, Standardization of* 127
Benzyl Chloride, *Manufacture of* 272
B-Naphthol *Derivatives for Disinfection Purposes* 172

BOOK REVIEWS:
  "The Aniline Color, Dyestuff and Chemical Conditions," by I. F. Stone 144
  "Annual Chemical Directory of the U. S." 145
  "Color Trade Journal," Vol. 1, No. 1, August, 1917 ... 229
  "How to Build Up Furnace Efficiency," by Joseph W. Hayes 179
  "Notes on Military Explosives," by Erasmus M. Weaver. 179
Business *Chemistry* 1
Cadmium *Derivatives of Acridine Dyestuffs for Use as Bactericides* 147
Carotin, *Toxicity of* 304
Chemical Control *in the Leather Industry* 12
Chemical Industry, *Outlook for the British* 304
Chemical Investigation, *Efficiency and Control* 33, 77, 115, 155, 197, 237, 272, 310
Chemical Progress, *America's* 126
Chemicals ? *After the War—What of the Export Trade in* 161
Chemicals, *British Imports and Exports of* 143
Chemist *and the Fertilizer Crisis, The Industrial* 86
Chemist *Must Enlist, The American* 41
Chemistry *and Engineering* 18
Chemistry, *Business* 1
Chrome Mordant, *A New Method for the Use of* 135
Coal-Tar, *The British Supply of* 254
Coal-Tar Chemical *Industry in Canada, Progress of the* .. 307
Coal-Tar Chemistry Section, *Foreword to* 121
Coal-Tar Chemists *to Advise Government* 126
Coal-Tar Color *Industry in Other Lands, Growth of the.* 133
Coal-Tar Colors *in England, the Manufacture of; Part I, Position on the Outbreak of War* 129
Coal-Tar Colors *in England, Manufacture of; Part II, Progress in British Dye Making* 130
Coal-Tar Colors, *Swift Expansion of the American Manufacture of, Analytical Studies on* 245, 173
Crudes *in Australia, Coal-Tar* 254
Coal-Tar Derivatives, *Theoretical Studies on* 173
Coal-Tar Dyes *on Leather, The Use of* 176

McCready Publishing Company

118 East Twenty-Eighth Street New York City

Coal-Tar Dyes *as Medicines*.......... 143
Coal-Tar Dyestuff *Industry: Its Development and Permanency in the U. S., The*.......... 110
Coal-Tar *and Explosive Industries, The German*.......... 254
Coal-Tar Intermediates, *Electrolytic Production of* 128
Coal-Tar Plant, *Leeds Chemical Firm Buys*.......... 114
Coal-Tar Research *at Huddersfield*.......... 135
Coal-Tar, *Synthetic Drugs Obtained from*.......... 139
Coking *Practice, Lines of Advance in*.......... 128
Coloring Material *of Rice Leaves, The*.......... 302
Color *Concentrations and Values, The Necessity for an Early Standardization of*.......... 165
Color, *Government Activity in the Field of*.......... 205
Color Industry, *British Profits in the Artificial*.......... 147
Color Manufacturers, *Profits of Swiss*.......... 145
Color Patents *in Great Britain, War-Time Use of*.......... 135
Color Technology, *The Physical Basis of*.......... 223
Colorimetric Test *for the Determination of Organic Impurities in Sands, The*.......... 9
Coloring Substances, *The Examination of Food-*.......... 175
Colors *for Army Uniforms*.......... 265
Colors, *The Combination of the Leading German Manufacturers of Artificial*.......... 266
Colors, *The Estimation of Coal-Tar*.......... 221
Colors, Natural, *References to Articles on*.......... 304
Colors, *Proposes Modification in the Tariff on Artificial*. 176
Colors, *The Purity and Strength of American Artificial*.. 241
Colors, *The Reliability of American*.......... 246
Commercial Development *of Technical Businesses, The*.. 59
Cotton *Fumigated with Hydrocyanic Acid Gas, Manufacturing Tests of*.......... 104
Cotton; *the Hydrocyanic Acid Gas Process for Fumigating Baled*.......... 37
Cream of Tartar *in the Fruit of Grapes, Crystallization of* 15
Development *of Technical Businesses, The Commercial*.. 59
Disastrous Conflagration *in the Factory of the Seydel Mfg. Co.*.......... 230
Disazo Dyestuffs, *New Wool*.......... 226
Diseases *Incident to the Manufacture of High Explosives*. 172
Distillates: *News Notes of Chemical and Allied Industries* 39, 78, 116, 156, 198, 238, 280
Divi-Divi Extract.......... 303
Drugs, *Analysis of Synthetic*.......... 178
Drugs *Obtained from Coal-Tar, Synthetic*.......... 139
Dye, *Autumnal Foliage as a Source of*.......... 270
Dye *Discoveries Reported, New*.......... 135
Dye Extract *Works in Jamaica*.......... 303
Dye Formulas, *Theft of*.......... 273
Dye Strength *in England, Standards of*.......... 263
Dyeing, *Apparatus for*.......... 303
Dyeing, *The Art of*.......... 227
Dyeing Machine, *A New*.......... 177
Dyeing *By Means of Nitrous Acid and Metallic Salts*.... 303
Dyeing *of the New Standard Khaki in England*.......... 264
Dyeing, *Reference to Papers on*.......... 177
Dyes, *After The War, American*.......... 26
Dyes *in British Industries, Present Position of Natural*.. 136
Dyes *in China, Reserve Stocks of Artificial*.......... 267
Dyes *from Chromotropic Acid, New Azo*.......... 298
Dyes, *The Development of American*.......... 75
Dyes *in Forensic Analysis and Microscopic Technique, Artificial*.......... 175
Dyes *as Medicines, Use of Coal-Tar*.......... 143
Dyes, *New Black Sulphur*.......... 177
Dyes *from Patent Blue, New Class of*.......... 299
Dyes, *Says U. S. Army Heads Discriminate Against Vegetable*.......... 138
Dyes *in the United States, Aniline*.......... 34
Dyestuff Industry: *Its Development and Permanency in the U. S., The Coal-Tar*.......... 110
Dyestuff Industry, *Government Control of the British*.... 224
Dyestuff Industry, *Growth of the American*.......... 260
Dyestuff Industry, *A New Factor in the American*...... 204
Dyestuffs *as Antiseptics, Artificial*.......... 175
Dyestuffs *from 2.5.7-Amino-Naphthol-Sulfonic Acid*.... 175
Dyestuffs *for Leather*.......... 176
Dyestuffs, *Manufacture of Copper Compounds of Ortho-Oxy Azo*.......... 298
Dyestuffs, *Women and*.......... 244
Dyestuffs *from Yacca Gum and Congo Resin*.......... 177
Eastern States Exposition.......... 166
Electrochemical Society, *Thirty-first General Meeting of The American*.......... 133
Electrolytic *Production of Coal Tar Intermediates*...... 128
Engineering, *Chemistry and*.......... 18
Estimation *of Free Acids in Solution The*.......... 28
Explosibility *of Pyrites and the Effect of This Quality Upon Its Available Sulphur and the Sulphur Content of Cinders Determination of the*.......... 181
Explosion *in an Aniline Plant, Remarkable*.......... 169
Explosion *in Barrett Co. Plant*.......... 127
Explosion *in the Beckers Works*.......... 230
Explosion *in the Works of the Midvale Co.*.......... 230
Explosions *of Oxygen, Government Investigates Fatal*.. 38
Explosive Industries, *The German Coal-Tar and*.......... 254
Explosives, *Diseases Incident to the Manufacture of High* 172
Explosives, *"Nitron" as a Gravimetric Reagent for the Analysis of Substances Used in*.......... 90
Export Licenses.......... 208
Exposition *of Chemical Industries, The Significance of the National*.......... 282
Exposition *of Chemical Industries, Program of Third National*..........facing p 201
Exposition *of Chemical Industries, Third National*...... 153
Exposition, *Eastern States*.......... 166
Exposition *is Nearing Completion, Program for*.......... 187
Exposition Week *of September 24, Addresses to Feature Chemical*.......... 235
Fertilizer *Crisis, The Industrial Chemist and the*....... 86
Flotation Oil, *and a New Source of Flotative Agents, A New*.......... 67
Food-Coloring *Substances, The Examination of*.......... 175
Foreign Trade *Opportunities*......79, 118, 158, 199, 239, 280
Foreword *to Coal-Tar Chemistry Section*.......... 121
Fumigating *Baled Cotton, The Hydrocyanic Acid Gas Process for*.......... 37
Gasolines, *Government Tests of: Physical and Chemical Properties of Many Varieties Sold Throughout the U. S. During* 1915.......... 42
Glass *Mixtures Being Studied, Refractories and*.......... 114
German *Artificial Color Company, Situation of the Leading*.......... 208
Glycerine, *The Recovery of*.......... 31
Grapes, *Crystallization of Cream of Tartar in the Fruit of*. 15
Gum *and Congo Resin, New Dyestuffs from Yacca*...... 177
Hydrocyanic Acid Gas *Process for Fumigating Baled Cotton, The*.......... 37
Indigo, *American Synthetic*.......... 135
Indigo *in Central America, Increased Cultivation of*...... 304
Indigo Industry *in India, Development of the Natural*.... 300
Indigo, *Natural*.......... 137
Indigo, *the Use of Bacteria in the Preparation of Natural* 302
Indicator, *A New and Sensitive*.......... 258
Isakovics, *Death of Alois von*.......... 178
Lakes *Derived from Complex Tungstic Acids, New*...... 225
Lakes *in the Dihydro-Anthraquinone Series*.......... 177
Lakes, *Use of Phosphomolybdic Acid in Producing Color*. 226
Lead Ores *of Low Grade, High Extractions from*....... 74
Leather, *Dyestuffs for*.......... 176
Leather Industry, *Chemical Control in the*.......... 12
Leather, *The Use of Coal-Tar Dyes on*.......... 176
Mangrove *and Wattle Barks, Comparative Tests with*.... 69
Merger *of Leading Manufacturers of Coal-Tar Crudes, Intermediates and Colors, The*.......... 122
Merger *of Leading Manufacturers of Coal-Tar Crudes..... Intermediates and Colors, The*.......... 167
Naphtha, *The "Cracking" of Solvent*.......... 168
Naphthalene *for Use as Insecticide, New Form of*....... 169
Naphthols *by the Aid of Sulfotitanium, Differentiation of the Two*.......... 220
National Aniline *and Chemical Co., The New Location of the*.......... 246
Nitrated Phenols, *Preparation of Picric Acid and Other*. 22
Nitro-Carbazole. *Reference to Article on*.......... 174
"Nitron" *as a Gravimetric Reagent for the Analysis of Substances Used in Explosives*.......... 90
Norton's *Announcement of Affiliation with the* CHEMICAL ENGINEER, *Dr. Thomas H.*.......... 83
Oakes Co. *to Erect New Buildings*.......... 143
Oil, *and a New Source of Flotative Agents: a New Flotation*.......... 67
Oils *in Southern China, Japanese and American*.......... 68
Oxygen, *Government Investigates Fatal Explosions of*... 38
Paper Pulp, *Lalang Grass as a New Source of*.......... 114
Patent *Law to Protect Government from Extortion, May Waive*.......... 143
Peat, *Clothing from*.......... 73
Perfumes, *Current Production of Synthetic*.......... 178
Perfumes, Synthetic: *Possibilities of English Manufacture*. 138
Perfumery, *Increased Cost of*.......... 272
Petroleum, *Government Report on Shales Yielding*...... 109
Phenol *from American Coal Tar*.......... 206
Phenol, *Artificial*.......... 244
Phenol *in Crude Carbolic Acid and Tar Oils, The Determination of*.......... 209
Phenols, *a Cyclic Process for the Manufacture of*....... 128
Phenols, *Preparation of Picric Acid and Other Nitrated*.. 22
Phosgene, *Manufacture of*.......... 220

Photographic Developers, *Effect of the War on the Production of* 142

Phthalic Acid *and Its Anhydride, A New Process for the Production of* 187

Picric Acid, *from Certain Gums* 141

Picric Acid, *Explosions of* 257

Picric Acid, *and Other Nitrated Phenols; Preparation of.* 22

Picric Acid, *Quantitative Estimation of* 220

Picric Acid *from Wash Water, Recovery of* 171

Platinum *Consumption of the United States* 195

Potash *from Banana Stalks, Possibility of the Recovery of* 89

Potash *"Noose," The* 84

Prices *of Chemicals,* March, 40; April, 80; May, 120; June, 160; July, 200; August, 240.

Prices *of Coal-Tar Products, Current Wholesale.* June, 146; July, 179; August, 230; September, 273; October, 308.

Imports and Exports *of Coal-Tar Products and Natural Dyestuffs* 231, 274, 309

Primuline, *The Discovery of* 296

Problems *of Today, Some Technochemical* 62

Program *of Third National Exposition of Chemical Industries* ....facing p. 201

Pulp, *Lalang Grass as a New Source of Paper* 114

Pyrites, *Determination of the Explosibility of: And the Effect of This Quality Upon Its Available Sulphur and the Sulphur Contents of Its Cinders* 181

Radium *to Carbonates, Conversion of Barium and* 66

Refractories *and Glass Mixtures Being Studied* 114

Research, *Co-operation in* 243

Research, *Nationality and Chemical* 143

Research, *The Organization of National Industrial* 201

Resin, *New Dyestuffs from Yacca Gum and Congo* 177

Rice Leaves, *the Coloring Material of* 302

Sands, *Colorimetric Test for the Determination of Organic Impurities in* 9

Salvarsan 178

Salvarsan, *Cost of* 143

Salvarsan *of Domestic Make* 271

Saccharin, *French Duty on* 143

Saccharin *Now Permissible in France, Limited Use of.* 178

Silica *Determination in Commercial Analysis, Accurate* ... 100

Soda *Deposit in East Africa, Development of Raw* 103

Sodium Phenate, *Improved Method of Making* 307

Sodium Phenetidino-methane-sulfonate 178

Sodium Salicylate, *New Method for the Preparation of* .. 170

Some Technochemical *Problems of Today* 62

Standardization *of Benzol Tests in Coke Works* 127

Stimulants, *Antipyretic* 272

Sulfonating *Kettles* 254

Sulfonic Acids, *Manufacture of* 129

Sulfotitanium, *Differentiation of the Two Naphthols by the Aid of* 220

Sulfur Dyes, *New Black* 177

Sulfur Yellows, *A New Series of* 224

Swiss *Color Industry, The* 245

Tar Distillation, *Improvements in* 169

Tartar *in the Fruit of Grapes, Crystallization of Cream of.* 15

Technochemical *Problems of Today, Some* 62

Tennis *Star Becomes Industrial Chemist* 74

Textiles, *a Foaming Process for Treating* 303

Theft *of Dye Formulas* 273

Third National Exposition *of Chemical Industries* 153

Toluene, *The American Supply of* 207

Toluene *in Crude Petroleum, Estimation of* 168

Toluene *for High Explosives, Some Sources of Benzene and* 249

Toluene *from Illuminating Gas, The Recovery of* 250

Trinitro-Toluene, *The Evolution of* 170

Ultra Violet Light; *Its Application in Chemical Arts.* Part I, 2; II, 54; III, 95; IV, 148; V, 188; VI, 232; VII, 311.

Uranium Oxide *Prepared by New Method* 109

Waste Disposal *Plants, Improvements in* 16

Women *and Dyestuffs* 244

Yellows, *A New Series of Sulfur* 224

Authors' Index

Abrams, Duff A., *The Colorimetric Test for the Determination of Organic Impurities in Sands* 9

Alcock, F., *Comparative Tests with Mangrove and Wattle Barks* 69

Alwood, William B., *Crystallization of Cream of Tartar in the Fruit of Grapes*............. 15

Armour, B. R., *American Dyes—After the War*.. 26

Armstrong, H. E., *Outlook for the British Chemi-Indigo Industry in India*................ 300

Armstrong, H. E.,*Outlook for the British Chemical Industry* 304

Bacon, Dr. Raymond F., *Some Technochemical Problems of Today*.................... 62

Baker, T. Thorne, *Effect of the War on the Production of Photographic Developers*........ 142

Barab, J., *"Nitron" as a Gravimetric Reagent for the Analysis of Substances Used in Explosives* 90

Bolton, Clement, *The Art of Dyeing*........... 227

Bruce, George H., *America's Chemical Progress*. 126

Carpenter, Charles, *Chemistry and Engineering*. 18

Coombs, F. A., *Comparative Tests with Mangrove and Wattle Barks*...................... 69

Cope, W. C., *"Nitron" as a Gravimetric Reagent for the Analysis of Substances Used in Explosives* 90

Davis, Charles B., *Chemical Investigation, Efficiency and Control*........33, 77, 115, 155, 197, 237, 279, 310

Dean, E. W., *Government Tests of Gasolines: Physical and Chemical Properties of Many Varieties Sold Throughout the U. S. During 1915* 42

Dean, William S., *Manufacturing Tests of Cotton Fumigated with Hydrocyanic Acid Gas*..... 104

Downs, C. R., *The Determination of Phenol in Crude Carbolic Acid and Tar Oils*......... 209

Ellis, Carleton, *Preparation of Picric Acid and Other Nitrated Phenols*.................. 22

Ellis, Carleton, *Ultra Violet Light: Its Application in Chemical Arts*......Part I, 2; II, 54; III, 95; IV, 148; V, 188; VI, 232; VII, 311

Gibson, George H., *The Commercial Development of Technical Businesses*.................. 59

Green, Arthur G., *The Discovery of Primuline*.. 206

Gyzander, C. R., *Determination of the Explosibility of Pyrites, and the Effect of This Quality Upon Its Available Sulphur and the Sulphur Content of Its Cinders*............. 181

Hammond, David Quick, *Chemical Control in the Leather Industry* 12

Harder, Oscar E., *The Colorimetric Test for the Determination of Organic Impurities in Sands* 9

Hawley, F. G., *Accurate Silica Determination in Commercial Analysis* 100

Jacobs, W. A., *Government Tests of Gasolines: Physical and Chemical Properties of Many Varieties Sold Throughout the U. S. During 1915* 42

Lint, H. Clay, *The Industrial Chemist and the Fertilizer Crisis*........................ 86

McKerrow, H. Gardner, *The Necessity for an Early Standardization of Color Concentrations and Values*....................... 165

Moore, G. A., *The Recovery of Glycerine*...... 31

Norton, Thomas H., *Foreword to Coal-Tar Chemistry Section* 121

Norton, Thomas H., *The Potash "Noose"*....... 84

Norton, Thomas H., *The Significance of the National Exposition of Chemical Industries*.. 282

Parry, Ernest J., *Synthetic Perfumes: Possibilities of English Manufacture*............... 138

Rabinovitz, Louis, *Preparation of Picric Acid and Other Nitrated Phenols*.................. 22

Ralston, Oliver C., *A New Flotation Oil, and a New Source of Flotative Agents*........... 67

Reeser, Myron Drew, *The Development of American Dyes* 75

Rhead, T. F. E., *Some Sources of Benzene and Toluene for High Explosives*............. 249

Richardson, F. W., *The Estimation of Free Acids in Solution*........................... 28

Rittman, W. F., *Government Tests of Gasolines: Physical and Chemical Properties of Many Varieties Sold Throughout the U. S. During 1915* 42

F. W. Shulenberger, *The American Manufacture of Laboratory Apparatus*................. 275

Sington, T., *Explosions of Picric Acid*.......... 257

Stelling, A., *Comparative Tests with Mangrove and Wattle Barks*....................... 69

Stone, I. F., *Aniline Dyes in the United States*... 34

Stone, I. F., *The American Coal-Tar Color Industry; Its Development and Permanency in the United States*....................... 110

Tuska, Gustave R., *Improvements in Waste Disposal Plants* 16

Wells, A. A., *Preparation of Picric Acid and Other Nitrated Phenols*.................. 22

Wells, A. A., *Ultra Violet Light: Its Application in Chemical Arts*......Part I, 2; II, 54; III, 95; IV, 148; V, 188; VI, 232; VII, 311

Weiss, John Morris, *The Determination of Phenol in Crude Carbolic Acid and Tar Oils*...... 209

Whittaker, C. M., *The Dyeing of the New Standard Khaki in England*.................... 264

Whittaker, C. M., *The Manufacture of Coal-Tar Colors in England. Part I, Position on the Outbreak of War*...................... 129

THE CHEMICAL ENGINEER

VOL. XXVI. NOVEMBER 1917 No. 1

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, NOVEMBER, 1917

Some Qualitative Tests for Gum Arabic and Its Quantitative Determination 2
C. E. Walters and *J. B. Tuttle.*
Concerning the Manufacture of Phthalic Acid and Phthalic Anhydride 7
Coal-Tar Chemistry Section.
Conducted by Thomas H. Norton.
Under which is included:

EDITORIALS:

Death of Dr. Eugene F. Roeber 8
Exemption of Chemists from Military Duty ... 9
A Threatened Shortage of Sulphuric Acid 9
Prospective German Competition in the Color Trade 10
Prospective Competition of Japan in the Manufacture of Dyestuffs 11
American Coal-Tar Products Industry to be Ascertained by the United States Tariff Commission 12

COAL-TAR CRUDES:

Crude Benzols 12
The Tar Industry of Great Britain 12
Distillation of Tar Oils 13
Control of Coal-Tar in Great Britain 13

COAL-TAR INTERMEDIATES:

The Manufacture of Anthraquinone 13
A New Class of Anthraquinone Intermediates. 14
Picric Acid Works in Great Britain 15
Serious Explosion in a Munitions Plant 15
Catalytic Synthesis of Aromatic Substitution Products 16
Catalytic Production of Aromatic Amines 16
Manufacture of Trinitrotoluene 16

ARTIFICIAL COLORS:

Reinstatement of the Dyestuff Industry in England 17
Professor Arthur G. Green.
Japan's Purchase of American Dyes 18
The Revival of the French Dye Industry 19
The Swiss Dyestuff Industry in 1916 19
Japanese Dyestuff Industry 20

NATURAL DYES:

Preparations for Indigo Fermentation Vats ... 20
Vegetable Dyes in the Philippines 21
Seaweed as a Dyestuff 21
The Dyeing of Chinese Rugs 22
Chinese Indigo 22

SYNTHETIC DRUGS AND PERFUMES; PHOTOGRAPHIC DEVELOPERS:

The Rôle of Saccharin During the War 23
Enlargement of the Monsanto Works 23
Army Supplies 23

MISCELLANEOUS:

The Federal Dyestuff and Chemical Corporation 24
Current Literature 24
Intra-Vitam Color Reactions 24
Decolorizing Carbon 25
Utilization of By-Products 25
New Book on Color 25
Fire in a Salicylic Acid Plant 25

CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS:

Crudes, Intermediates and Explosives, Synthetic Medicinals, Flavors and Extracts; Photographic Developers, Artificial Colors 26
Natural Dyestuffs, Dyewoods and Raw Materials, Extracts, Dyeing Accessories 27
Imports and Exports of Coal-Tar Products and Natural Dyestuffs 27
Ultra Violet Light: Its Application in Chemical Arts, Part VIII. 28
Carleton Ellis and *A. A. Wells.*
Postal Savings Deposits Will Not be Seized by the Government 34
Chemical Investigation, Efficiency and Control .. 35
Conducted by Charles B. Davis.
New Apparatus:
The Plaisance Extraction Apparatus.
An Optical Pyrometer for Works Use 36
Conducted by F. W. S.
Foreign Trade Opportunities 39
Distillates; News Notes of Chemical and Allied Industries 40

DYE MAKING IS THE MONEYMAKER—I will rent to a corporation or capitalist who can make necessary improvements a suitable factory building and grounds located in eastern Pennsylvania on L. V. R. R. switch; river in rear; ample sewerage; cheap fuel; lot 375 x 200; equipped with two boilers 72 x 16, a 150 H. P. Corliss engine and 80-ton refrigerating compressor all ready to steam up and go ahead. A grand opportunity for a new company to get a factory. Monthly rent $150. Address Box 374, CHEMICAL ENGINEER.

SOME QUALITATIVE TESTS FOR GUM ARABIC AND ITS QUANTITATIVE DETERMINATION

By C. E. Waters and J. B. Tuttle*

The Object of This Paper Is to Bring Together All the More Important Qualitative and Quantitative Methods That Have Been Published, and to Present a New Procedure for the Determination of Gum Arabic. The True Gums Do Not Readily Lend Themselves to Reactions of Definite Qualitative and Quantitative Value, and Therefore the Following Summary of Qualitative Tests Should Be of Interest, As Many of the Quantitative Methods Depend on the Same Reactions.

INTRODUCTION.

The group of polysaccharides includes such diverse substances as the starches, cellulose, the dextrins, the gums, and the plant mucilages. They possess in common the property of being decomposable hydrolytically into one or more sugars, usually pentoses or hexoses. By oxidation, the acids corresponding to these sugars are formed, but the first step toward this reaction appears to be hydrolysis.

The true gums, of which gum arabic is typical, dissolve in cold water, yielding clear solutions which, though viscous and adhesive, can be filtered. The closely related and quite similar mucilages, such as gum tragacanth and cherry-tree gum, simply swell up and form more or less homogeneous suspensions that can not be filtered. Perhaps most of the so-called gums are mixtures of one or more representatives of each of the above two classes.

As might be expected from their chemical nature, the gums do not readily lend themselves to reactions of a definite qualitative or quantitative value. One of us learned how unsatisfactory some of the qualitative tests are when samples of mucilage first came to the Bureau of Standards for examination. This led to an extended study of the literature and of the various qualitative reactions that have been published and finally to a comparatively accurate quantitative method. In the last part of this work the two of us joined forces, hoping to carry on a much more extended investigation than was found later to be possible.

The object of this paper is to bring together all the more important qualitative and quantitative methods that have been published and to present a new procedure for the determination of gum arabic. Since in most cases it is necessary to know only whether gum arabic is present or not, it is believed that the following summary and criticism of the qualitative tests will be of value. Many of the quantitative methods depend on the same reactions.

QUALITATIVE TESTS.

In nearly all cases a 2 per cent. solution of gum arabic was used. Similar solutions of dextrin and of gum ghatti, a substitute for gum arabic, were subjected to the same tests.

1. Ferric Chloride and Alcohol.—A solution of ferric chloride, made up without the addition of hydrochloric acid and filtered to remove a small amount of basic salt, was used. It contained about 25 g of the salt in 100 cc. Neither gum arabic, gum ghatti, nor dextrin gave a precipitate with this reagent.

A mixture of 2½ volumes of 50 per cent. alcohol and the ferric-chloride solution precipitates gum arabic, though often only on long standing.[1] Gum ghatti gives no precipitate, and dextrin a very slight one.

2. Potassium Hydroxide.—According to Liebermann,[2] solutions of gum arabic and of dextrin become amber-yellow when warmed with potassium hydroxide, while the closely related gum senegal gives at most a faint yellow color. Sollman[3] stated that dextrin, when so treated, turns more or less brown, while some sugars and gums, other than arabic, behave similarly. Rideal and Youle[4] came to the conclusion that this test is of no value. Two samples of gum arabic, among a number tested by them, gave a green color. They found that a solution of ghatti turns pink and dextrin a very dark red or almost black. Nevertheless, this test is among those recommended in the latest edition of Lunge.[5]

Our experiments with gums and sugars amply confirmed the statement that this test is of no value.

3. Color Reactions with Phenols.—Reiche[6] found that gum arabic gave a flocculent blue precipitate when boiled with orcinol and concentrated hydrochloric acid. Other carbohydrates, including dextrin, cellulose, sugars, starch, and a number of gums, gave yellow or brown colors.

Ihl[7] was able to distinguish between gum arabic, dextrin, and starch by means of *a*- and *b*-naphthol and phloroglucinol. With resorcinol and pyrogallol, all three carbohydrates gave the same color.

---

*From a Technologic Paper issued by the U. S. Bureau of Standards.

[1] Roussin: J. Pharm. Chim. [4], 7, p. 251; 1868. See also Allen, Coml. Org. Anal., 4th ed., 3, p. 113.

[2] Chem.-Ztg., 14, p. 665; 1890.

[3] Am. J. Pharm., 83, p. 176; Chem. Zentr., 82, 1, p. 1560; 1911.

[4] J. Soc. Chem. Ind., 10, p. 610; 1891.

[5] Chem.-Techn. Untersuchungsmeth., 6th ed., 3, pp. 167-168; 1911.

[6] Ber. Ges. Förder. chem. Ind., 1879, p. 74; Chem.-Ztg., 4, p. 191; 1880.

[7] Chem.-Ztg., 9, p. 231; 1885.

In this connection may be mentioned a curious reaction discovered by Clermont and Chautard.[8] A solution of pyrogallol, containing gum arabic, gave a yield of 67 per cent. of the condensation product, purpurogallin (pyrogalloquinone), on standing for two months.

In the hope of obtaining definite color reactions, hydrochloric acid-alcoholic solutions of the following phenols were made up: Phenol, resorcinol, pyrocatechol, guaiacol, hydroquinol, pyrogallol, phloroglucinol, and *a*- and *b*-naphthol. These were heated, in test tubes set in beakers of water on the steam bath, with dextrin and gums arabic, ghatti, and tragacanth. A considerable range of colors resulted: Pale yellow, pale pink, red-brown, brown, pale orange, purple-red, etc., but no reliance could be placed in any of the reactions as a means of identification.

Some interesting results were obtained by heating the same carbohydrates with alcohol and hydrochloric acid, without the addition of a phenol. Dextrin gave no color, gum arabic a pale yellow, and tragacanth a pale pinkish-yellow. A sample of gum ghatti, prepared by powdering together a number of lumps taken at random, gave a pale-yellow solution with perhaps a tinge of pink. The addition of a clear lump of the gum caused no change, while a dark, impure piece produced a dark pink. There may be some connection between these color reactions and the behavior of different lumps of ghatti toward the guaiacol-hydrogen peroxide reagent, which is discussed further on.

4. Basic Lead Acetate.—An aqueous solution of neutral lead acetate precipitates neither dextrin nor gums arabic and ghatti. An alcoholic solution of the salt does, however, slowly precipitate gum arabic.[9]

As might be expected from its employment in clarifying sugar solutions before polarization, basic lead acetate is an excellent precipitant for many gums. The solution may be made basic either by adding ammonia,[10] or by boiling with litharge. The precipitate formed when gum-arabic solution is added is of a peculiar curdy consistency, and of such characteristic appearance that it is hardly necessary to make any confimatory tests.

Allen[11] speaks of this precipitate as a "white jelly." Dextrin solutions are, at most, made slightly cloudy by the reagent, while gum ghatti yields a very small amount of precipitate, most of which remains suspended in the liquid.

The basic acetate solution used by us was made by long-continued boiling of 40 g of crystallized lead acetate, dissolved in 250 cc of water, with an excess of litharge. It was filtered, after which it remained clear for a long time.

Basic lead acetate has been recommended probably more frequently than any other reagent as a qualitative test for gum arabic, as well as for removing this and other gums from wines, liquors, etc., in which other constituents are to be determined.[12]

5. Copper Sulphate and Sodium Hydroxide.—Jettel[13] does not mention the basic lead acetate test, but relies chiefly upon the behavior of dextrin, gum arabic, etc., toward copper sulphate and sodium hydroxide. The test was devised by Liebermann[14] for detecting dextrin and gum senegal in the presence of gum arabic. The precipitate formed in a solution of gum arabic by adding copper sulphate and then an excess of sodium hydroxide, balls together and rises to the top. That from senegal is less in amount and is in finer particles that remain distributed throughout the liquid. On warming, these precipitates dissolve to only a slight extent, and even on boiling there is no reduction to cuprous oxide. A solution of dextrin yields a precipitate that dissolves on warming. The cupric salt contained in the dark-blue liquid is completely reduced by boiling.

To these statements of Liebermann we may add that gum ghatti gives a dark-blue solution which is, at times, slightly turbid, but clears up on warming gently. There is slight reduction on boiling, but this may not be noticed unless a long time is allowed for the cuprous oxide to settle.

In the second part of this paper is described a quantitative method for gum arabic, based on a modification of Liebermann's reagent.

6. Miscellaneous Qualitative Tests.—Many other reagents for gum arabic have been suggested from time to time, but most of them deserve only brief mention.

One of the most interesting of these depends on the presence of an oxidase in gum arabic, and was devised for the detection of this gum when mixed with tragacanth, in which there is no such enzyme.[15] To a suspension of the powdered gum in 30 parts of cold water is added an equal volume of a 1 per cent. aqueous solution of guaiacol, followed by a drop of hydrogen peroxide. If gum arabic is present, the mixture at once turns brown. Dextrin, of course, does not react. Gum ghatti may not react, even after standing for half an hour. With some pieces, however, the color is produced. This recalls the behavior of the gum toward a mixture of alcohol and hydrochloric acid. (See under 3, above.)

Bornträger[16] suggested warming a suspected sample with 50 per cent. hydrofluoric acid. When much bone glue is present, the odor of butyric acid is noticed. Dextrin is detected by its own characteristic odor, while with gum arabic only that of hydrofluoric acid is noticed.

---

[8] Compt. Rend., 94, p. 1254; Jahresber., 1882, p. 684.

[9] Chauvin: Mon. Sci., [5], 1, pp. 317-8; 1911; Chem. Zentr., 82, 1, p. 1656; 1911.

[10] v. Lippmann: Chemie der Zuckerarten, III Aufl., p. 1616.

[11] Loc. cit.

[12] Rideal and Youle: J. Soc. Chem. Ind., 10, p. 610; 1891.
Fromm: Z. anal. Chem., 40, p. 143; 1901.
Papasogli: L'Orosi, 21, pp. 263-265; 1898.
Scheibler: Z. Ver. d. Zuckerind., 23, p. 288.
Battut: Sucr. Indig. et Colon., 32, p. 285.
v. Lippmann: Chemie der Zuckerarten, p. 1616.
Allen: Coml. Org. Anal., 4th ed., 1, pp. 44 et seq.

[13] "Zündwaren" in Lunge: Chem.-Techn. Untersuchungsmeth., 6th ed., 3, pp. 167-168.

[14] Chem.-Ztg., 14, p. 665; 1890.

[15] Payet: Apoth. Ztg., 25, p. 116; Z. anal. Chem., 44, p. 453; 1905.

[16] Oesterr. Chem. Ztg., 3, p. 1888; Z. anal. Chem., 40, p. 131; 1901.

According to Petri,[17] aliphatic aldehydes, certain sugars, and gum arabic give a fuchsin-red color when mixed with alkali and diazobenzenesulphonic acid. The color is gradually developed.

Günsberg[18] used a fresh solution of egg albumen, acidified with acetic or hydrochloric acid, as a reagent for gum arabic. Dextrin yields a dense precipitate which is insoluble in an excess of acid or of dextrin solution. With gum arabic only a little must be added, for the precipitate first thrown out dissolves in even a slight excess. Any albumen that is not precipitated by the gum arabic can be coagulated by heat, although under ordinary circumstances acidified albumen is not coagulable.

Vamvakas[19] found that as little as 5 per cent. of gelatin can be detected in gum-arabic mucilage by means of Nessler's reagent. The mucilage is shaken with one-fourth its volume of the reagent and allowed to stand. If no gelatin is present, the brownish-gray precipitate remains suspended for some days. With an admixture of gelatin the precipitate is dull gray and settles more rapidly. In the presence of tartaric acid even a 30 per cent. solution of gum arabic yields but a slight precipitate with Nessler's reagent.

These reactions call to mind the mixture of mercuric acetate and sodium chloride suggested by Hager.[20] When warmed with glucose there is no change, while gum arabic, dextrin, and cane sugar reduce the mercuric salt with formation of calomel.

In this connection also should be mentioned the reduction of molybdic acid when boiled with a solution of dextrin.[21] A blue solution results, while with gum arabic there is no change.

Analogous to the reaction with copper sulphate and alkali is the formation of a stable blue color when a solution of gum arabic or of dextrin is mixed with cobalt-nitrate solution, followed by dilute sodium hydroxide.[22]

Zsigmondy,[23] using a deep red solution of colloidal gold as a reagent for colloids, studied the color changes produced by glue, gums, albumen, etc.

Other reagents for gum arabic, such as sodium or potassium silicate, borax, or ammonium oxalate,[24] would seem to depend largely upon the natural calcium content of the gum, though some of the reagents are said to produce gelatinization.

In our work solutions of various salts were mixed with 2 per cent. solutions of gum arabic, but in no case was there precipitation or gelatinization. These salts need not be enumerated, except to say that, among others, such promising reagents as basic zinc salts and sodium zincate were found to be useless.

Gum arabic gives no color reaction with iodine solution.

7. Chief Qualitative Tests for Gums and Dextrin.—Most of the tests described above, as well as others not mentioned, were tried. Most of them were unsatisfactory. After the work had progressed far enough to show which tests are reliable we succeeded in obtaining new samples. The five or six lots already on hand were from different dealers and the original sources were not known. The new ones included gum arabic from Khartum and Kordofan, a second supply of gum ghatti, and the closely related gum gedda. It is unnecessary to discuss these in detail since their reactions are included in the table below.

TABLE 1

Chief Qualitative Tests for Gums and Dextrin

Reagent	Gum arabic	Gum ghatti	Gum gedda	Dextrin
Ferric chloride and alcohol.	Precipitate.......	Nearly clear.......	Slight precipitate....	Slightly cloudy.
Basic lead acetate..	Dense precipitate.	Cloudy...........	Less precipitate than arabic.	Slightly cloudy.
Copper sulphate and sodium hydroxide (cold).	Blue precipitate, colorless solution.	Dark-blue solution, often cloudy.	Light-blue precipitate, dark-blue solution.	Dark-blue solution.
As above, but boiled..	Precipitate darker, pale-blue solution.	Slight reduction	Precipitate darker. .	Complete reduction.
Iodine solution.......	(a)	(a)	(a)	Reddish-purple solution.

a No characteristic color reactions.

All samples of gum arabic, from whatever source, behaved alike. Gum gedda, it will be seen, acts much like a mixture of gums arabic and ghatti. Only the tests that are most reliable are included. The gum solutions were prepared by dissolving 1 g. of the solid in 50 cc of hot water and straining through a loose plug of cotton.

QUANTITATIVE METHODS.

Since the chemical nature of the gums is such as to render most of the qualitative tests of at least doubtful value, it is not surprising that there are difficulties involved in their quantitative separation and determination. Some of the methods that have been proposed will be reviewed below, following which our own procedure will be described.

1. Ferric Chloride and Calcium Carbonate.—The first qualitative test mentioned above was the formation of a precipitate when neutral ferric-chloride solution and alcohol are added to a solution of gum arabic. This precipitate is soluble in dilute acid, so that the gum is not completely thrown down unless the acid that is simultaneously set free is neutralized. Roussin[25] found that calcium carbonate is satisfactory for the purpose. The gum solution is mixed with alcohol and ferric chloride, and an excess of the carbonate is then added. The mixture of precipitated gum and ferric hydroxide, which is rather difficult to filter, is washed with alcohol, dissolved in hydrochloric acid, the gum thrown out by strong alcohol, washed with the same reagent, dried, and weighed.

Roussin devised this method for the quantitative separation of gum arabic from dextrin. It is recommended by Allen, and was found by Auguet to give good results in determining the gum in sirups.[26]

---

[17] Z. physiol. Chem., 8, p. 291; Jahresber., 1881, p. 1328.

[18] J. prakt. Chem., 88, p. 239; Z. anal. Chem., 2, p. 218; 1863.

[19] Ann. Chim. Anal. Appl., 12, pp. 12 and 130; 1907. Analyst, 32, pp. 93 and 226; 1907.

[20] Pharm. Centralhalle, 18, p. 313. Z. anal. Chem., 17, p. 380, 1878.

[21] Hager: Commentar zur ersten deutschen Pharmakopöe, II, p. 116. Cf. Stohmann in Muspratt, 4th ed., 3, p. 1917; 1891.

[22] Papasogli: L'Orosi, 21, pp. 263-265; 1898. Chem. Centr., 69, II, p. 991; 1898.

[23] Z. anal. Chem., 40, p. 697; 1901.

[24] Allen: Loc. cit., p. 411.

[25] Loc. cit. See also Allen; loc. cit.

2. Ferric Chloride and Sodium Carbonate.—Another method based upon the reaction with ferric chloride was suggested by Landwehr[27] for the determination of glycogen and, incidentally, of gum arabic. Concentrated ferric-chloride solution is added in slight excess, followed by concentrated sodium carbonate until all of the iron is thrown down. The precipitate is at once filtered off, washed with hot water, dried at 110°-120°, and weighed. It is then ignited and the weight of ash deducted from that of the precipitate.

Determinations were made of the percentages of water held by ferric hydroxide when dried to constant weight at different temperatures. A correction for this water, calculated from the excess of ferric chloride, is applied to the weight of the original precipitate. It is not clear, however, just how this excess is to be determined, nor is the retention of moisture by the precipitated gum taken into account.

3. Lead Acetate.—As already stated, Chauvin[28] suggested the employment of an alcoholic solution of neutral lead acetate for the precipitation of gum, especially from sirups, but found that long standing was necessary. Rocques and Sellier[29] also found that this procedure gives good results.

As far as we are aware, the basic acetate has not been used for the quantitative determination of gum. Various formulas have been ascribed to the precipitate,[30] and it is not unlikely that it may vary in composition.

4. Alcohol.—Chauvin,[31] on account of the slowness of precipitation when lead acetate is used, employed alcohol acidified with hydrochloric acid. The addition of the latter is not necessary, for the gums are all insoluble in strong alcohol. This has often been taken advantage of to remove them from wines, plant extracts, etc.[32]

5. Miscellaneous Methods.—Gum arabic can be hydrolyzed to a mixture of hexoses and pentoses by warming with dilute mineral acid, though not all samples yield these in the same proportions. Hence, quantitative methods based upon the use of Fehling's solution (hexoses), or upon the estimation of furol (pentosans) have failed.[33]

By digesting with moderately strong nitric acid, gum arabic is oxidized to mucic acid, which can be determined with fair accuracy, but samples of gum from different sources yield different percentages of the oxidation product.[34]

Williams,[35] working with quite a number of gums and resins, determined the iodine absorption number and the acidity of gum arabic, as well as the amount of alkali taken up when it is boiled with alcoholic potash. His figures showed that samples of gum differ so widely that methods involving these determinations are of no value.

6. Copper Sulphate and Alkali.—Madsen[36] estimated the gum in licorice juice (succus liquiritiae) by throwing it out with strong alcohol, dissolving in a little water, and then treating with a 10 per cent. solution of copper sulphate, followed by an excess of sodium carbonate. The precipitate is probably identical with that formed by the combined action of copper sulphate and sodium hydroxide. After filtering off the precipitate, it is washed with weaker and weaker soda solution, dissolved in dilute hydrochloric acid, and the gum thrown down by 85 per cent. alcohol. After washing with alcohol it is dried and weighed. The weight, multiplied by 1.21, gives the percentage of gum. This is not said to be identical with gum arabic, but for botanical reasons may well be quite similar to it.

During the course of our tentative experiments, and without knowledge of the work of Madsen, an attempt was made to precipitate gum arabic by means of copper sulphate (5 g of the crystallized salt in 100 cc of water) and sodium carbonate (13.25 g of the anhydrous salt in 100 cc of alcohol of the maximum strength that would give a clear solution). Whether the soda was added before or after the copper solution made no difference in the result. The filtrate was always cloudy, even though the precipitate was so gelatinous that filtration was very slow.

Promising, though still too low, results were obtained with 10 per cent. sodium hydroxide, instead of soda, followed by the addition of enough absolute alcohol to bring the total up to about 60 per cent. strength. The precipitate was washed with alcohol, dried, weighed, and ignited. After deducting the weight of the ash, the percentages of gum found in four determinations varied from 84.6 to 90.1. In each of these four determinations the weight of ash from the copper precipitate was a little greater than that of the gum taken, owing to the fact that there was a considerable excess of copper in the form of hydroxide. Since this increased the time required for drying, besides being otherwise objectionable, some qualitative tests were made with a modified Fehling solution, with the hope that these difficulties would be avoided. Twenty cubic centimeters of copper-sulphate solution and 55 cc of sodium-hydroxide solution, of the strengths stated above, were moved, enough Rochelle salt was added to dissolve the precipitate, and the whole diluted to 100 cc. To a solution of about 0.25 g of gum in 40 cc of water there was added 50 cc of the Fehling solution, but with no apparent change, except at times a slight cloudiness While stirring vigorously, 90 cc of 95 per cent. alcohol was then added, whereupon the familiar blue precipitate formed in fine particles that soon settled. Blanks showed that no cloudiness was produced in the Fehling solution when mixed with water and alcohol in the quantities stated.

---

[26] Ann. Falsific., 2, pp. 136-168; Chem. Abstr., 5, p. 538; 1911.

[27] Z. physiol. Chem., 9, p. 164; 1884.

[28] Footnote 9; see also Ann. Falsific., 5, pp. 27-30; Chem., Zentr., 83, I, p. 756; 1912.

[29] Ann. Chim. Anal. Appl. 16, pp. 218-220; 1911; Chem. Zentr., 82, II, p. 394; 1911.

[30] Riegel: Arch. Pharm. [2], 54, p. 155; Jahresber., 1, p. 795; 1847-48.
Battut: Suer. Indig. et Colon, 32, p. 285.
Scheibler: Z. Ver. d. Zuckerind., 23, p. 288.

[31] Loc. cit.

[32] Diehl: Pharm. Rundschau, 1, p. 31; Z. anal. Chem., 22, p. 622; 1883.
Madsen: Pharm. Centrallhalle, 20, p. 144; Z. anal. Chem., 22, p. 134; 1883.

[33] v. Lippmann: Loc. cit.

[34] Kilani: Ber. d. Chem. Ges., 15, pp. 31-37; 1882.

[35] Chem. News, 58, p. 221; Z. anal. Chem., 28, p. 732; 1889.

[36] Loc. cit. See footnote 32.

The precipitate was filtered off, washed successively with 50, 75, and 95 per cent alcohol, dried at 110° to 115°, weighed, etc., as before. Two determinations, made exactly as stated, gave the values 95.6 and 94.9 per cent of gum. When the gum was dissolved in 25, instead of 40 cc of water, the percentage found was 97.2. The original dried gum yielded 2.8 per cent of ash, chiefly calcium carbonate, with a little potassium carbonate. No correction was made for this ash in calculating the above percentages. In each of the three determinations just mentioned the weight of the ash from the copper percipitate weighed less than half as much as the gum.

Since the gum-copper precipitate is of a gummy nature, it is not possible to completely remove foreign salts by any amount of washing. Both copper sulphate and sodium sulphate are insoluble in alcohol of the strength used. This is not true of the respective acetates or of Rochelle salt, so that in another series of determinations copper acetate was employed. It is not necessary to go into details further to say that the results were a few per cent below or above 100 with varying dilution of the gum solution and of the Fehling solution, and according to the final percentage of alcohol in the mixture.

Even this reagent was not ideal, for there must always be present the excess of copper salt, as well as the Rochelle salt and the sodium hydroxide and acetate.

7. METHODS FINALLY ADOPTED.—Copper acetate dissolved in ammonia possesses obvious advantages over all the other solutions employed. In order to ascertain the best conditions for precipitation, a few preliminary tests were made. One-quarter gram of gum arabic was dissolved in 50 cc of water, 25 cc of ammoniacal copper-acetate solution (see below) added, and then enough alcohol to give the required percentage of the total volume of the mixture. Thirty per cent of alcohol gave no precipitate. With 40 per cent there was a faint precipitate, so finely divided that it was practically impossible to filter. With 50, 60, and 70 per cent of alcohol, respectively, dense and easily filtered precipitates were formed. The addition of more alcohol to the filtrates from these three caused no further precipitation. These precipitates gave on ignition the following amounts of ash, practically cupric oxide:

TABLE 2

Ash Found With Varying Alcohol Content

Alcohol	50%	60%	70%
Ash	G 0.0412 .0402 .0398	G 0.0436 .0446 .0452	G 0.0544 .0564 .0548
Average	.0404	.0445	.0552

From this it will be seen that in the presence of 50 per cent of alcohol the gum is precipitated quantitatively and carries down with it less occluded matter than when the mixture contains more alcohol.

The following procedure was finally adopted for the determination of gum arabic: Fifty grams of copper acetate was dissolved in water, an excess of ammonia added, and the solution diluted to 1000 cc, using water and alcohol in such proportions that the final solution contained 50 per cent of alcohol. For each determination a 50 cc portion of a gum-arabic solution, representing 0.25 of gum, was pipetted into a 250 cc beaker, an equal volume of alcohol added, and then 25 cc of the copper reagent, with constant stirring. The precipitate was allowed to settle, was filtered on a tared paper, washed with 50 per cent alcohol containing ammonia, then with 75 per cent, and finally with 95 per cent alcohol. It was dried to constant weight at 105°, ignited in a porcelain crucible, and the ash weighed. The amount of ash was deducted from the weight of the original precipitate and the difference called "net gum arabic." The amount of moisture in the gum originally taken from analysis must be allowed for. This is determined by drying in a current of hydrogen at 105°. No allowance is made for the potassium and calcium which form an integral part of the gum. These may be to some extent retained in the precipitate and, therefore, be included in the ash. And error that may be introduced by neglecting this is small and very much less than the error inherent in the method.

In some of the preliminary work the gum-copper precipitate was dried at 95° and then at 105°. The additional loss in weight at the higher temperature was usually about 3 or 4 mg, or 1.5 per cent.

The following table gives the results of a number of determinations on 0.25 g portions of gum. Since this contained 11.5 per cent of moisture, the amount of actual gum was 0.2213g. The precipitates were dried at 105°.

TABLE 3

Results Obtained By the Ammonia-Copper Acetate Method

Series	Total precipitate	Ash	Net gum	Percentage found	Average of series
	G	G	G		
A	0.2570	0.0433	0.2137	96.6	
	.2596	.0428	.2168	98.0	
	.2613	.0470	.2143	96.9	
	.2647	.0469	.2178	98.4	
	.2554	.0413	.2141	96.7	97.3
B	.2970	.0755	.2215	100.1	
	.2840	.0649	.2191	99.0	
	.2837	.0663	.2174	98.3	
	.2887	.0689	.2198	99.3	
	.3012	.0785	.2227	100.7	99.5
C	.2880	.0659	.2221	100.4	
	.2908	.0668	.2240	101.2	
	.2844	.0651	.2193	99.1	
	.2853	0646	.2207	99.7	
	.2827	.0640	.2187	98.8	99.9
D	.2880	.0633	.2247	101.5	
	.2927	.0653	.2274	102.8	
	.2982	.0697	.2285	103.3	102.5
General average				99.5	

It is evident from an inspection of the figures that the method as finally modified is capable of yielding as accurate as can be expected. It is realized, however, that much work could yet be done with mixtures of gum arabic with ghatti, dextrin, etc., as well as with mucilages of known composition. A few preliminary determinations, made while Fehling solution was still being experimented with, indicate that dextrin and ghatti tend to be carried down with the gum arabic. At the same time a sample of mucilage was prepared according to the formula in the United States Pharmacopoeia; from this the gum was precipitated by strong alcohol, dried, and analyzed. The net gum found in four determinations was about 91 per cent. This low result may be due to a fault of the method or to partial hydrolysis of the gum. The publication of the results thus far obtained has been so long delayed, and the opportunity to complete the work seems so remote, that it has been decided to present this paper without further postponement.

SUMMARY.

An incorrect report to the effect that a certain sample of mucilage contained no gum arabic led to a study of many of the published tests for this gum, as well as to a search for others than the few that proved to be reliable. It was found that basic lead acetate gives the most characteristic reaction, while mixtures of copper sulphate and sodium hydroxide, and of neutral ferric chloride and alcohol are of value as confirmatory tests.

A summary of the more important methods that have been proposed for the quantitative estimation of gum arabic is next given, followed by a description of the steps that led the authors to the use of alcoholic copper acetate,ammonia solution for this determination.

Concerning the Manufacture of Phthalic Acid and Phthalic Anhydride

The Department of Agriculture announced on June 16, 1917, that the Color Investigation Laboratory of the Bureau of Chemistry of this Department had perfected on a laboratory scale a new process for the manufacture of phthalic acid and phthalic anhydride, and invited cooperation with the manufacturers for the purpose of testing this laboratory process upon a commercial scale. It was also stated in the announcement that the offer of assistance would not be held open by the Department for an indefinite period.

Arrangements have been made with several concerns to test this process on a commercial scale and the Color Investigation Laboratory is not in a position to receive or handle any additional offers of cooperation. The offer made on June 16, 1917, therefore, is withdrawn and no additional offers of cooperation can be considered.

Prof. Judd to Edit A. I. M. E. Bulletin.

As a result of the resignation last June of B. A. Robinson as managing editor of the Bulletin of the American Institute of Mining Engineers, E. K. Judd has been appointed to fill the position. The latter was formerly of the Mining Department of Columbia University.

Primary Volatile Products of the Carbonization of Coal

Technical Paper 140, on the primary volatile products of the carbonization of coal, just issued by the Bureau of Mines, Department of the Interior, should prove of interest to the gas industry, as the authors, Guy B. Taylor and Horace C. Porter, suggest that as a result of their study the utilization of inferior coals in the making of gas may be found practicable.

The authors say that the results suggest the possibility that low temperature carbonization might be utilized in gas manufacture as an enriching process by passing through the low-temperature retorts a relatively large quantity of a thin gas, such as "blue-water gas," sweeping out the light oil vapors that are primarily liberated at these low temperatures.

The report is a continuation of the work described in Bureau of Mines Bulletin 1 on the character of the volatile matter of coal. The experimental methods have been refined and more precise results obtained.

The subject of carbonization is important in all industrial applications of coal, whether it be in gas manufacture or coke making, where it is paramount, or in those processes where coal is burned, such as in boiler furnaces, gas producers, and metallurgical furnaces. The results presented here are more or less of a fundamental character—a study of basic phenomena in carbonization, rather than of the ultimate results of these phenomena as a whole.

The authors, in their general conclusions, say: "A high-grade bituminous coal of the gas-making type decomposes by heat primarily into paraffin hydrocarbons and a completely altered nonvolatile residue, with small quantities of water, CO_2, and CO. The three latter products are the first produced, although in small quantity; from some other types of bituminous coal they are produced in greater relative quantities than from the gas-coal type. Complex and varied secondary reactions induced by superheating the hydrocarbons, water vapor, and CO_2 are of great importance in industrial high-temperature carbonization.

"The products of low-temperature carbonization from coal of the Pittsburgh type on an industrial scale at about 800° to 900° F. (427° to 482° C.) will consist of a rich gas amounting to 0.6 to 0.7 cubic foot per pound of coal, and a large yield of oil, or tar, comprising 10 to 12 per cent. of the coal. This tar consists chiefly of paraffin hydrocarbons, is very low or possibly entirely devoid of benzene and naphthalene derivatives and practically devoid of free carbon. The gas will contain 6 to 7 per cent. of unsaturated hydrocarbons and 20 to 25 per cent. of ethane and its higher homologues, and consequently will have a high calorific and illuminating value. The tar may be either redistilled or subjected to cracking processes so as to produce light oils—gasoline substitutes—whose yield will be greater than, and probably at least double, that obtained by high-temperature carbonization.

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors.
Synthetic Medicinals, Flavors and Perfumes. Explosives,
Photographic Developers.

Edited by
THOMAS H. NORTON, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

George H. Bruce, LL.B., Keystone Fibre Products Co., Inc., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hebden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles.

H. Gardner McKerrow, of E. F. Drew & Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

EDITORIALS

Death of Dr. Eugene F. Roeber

In the death on October 17, 1917, of Dr. Eugene Franz Roeber, the chemical journalism of New York City loses one of its most forceful and valued members.

Dr. Roeber was born in Torgau, Germany, October 7, 1867, and he had barely completed a half century at the time of his passing away.

His scientific studies were pursued at the Universities of Jena, Halle and Berlin. In 1892 he received the degree of Ph.D. at Berlin. He belonged to a family bitterly opposed to the oppressive restrictions of Prussianism, and soon after the completion of his studies sought the freer atmosphere of America.

Coming to the United States in 1894 he led for a few years an uneventful life in New York City, connected for some time with the Steiger book importing company. In 1899 he became the assistant of Dr. Carl Hering in Philadelphia, and soon made himself felt as a prominent factor in electrochemical circles. In connection with Dr. Hering and Mr. C. T. Reed he was instrumental in founding the American Electrochemical Society. The rapid growth and marked success of this organization has been largely due to his untiring efforts. It found an appreciative recognition in 1914, when he occupied the presidency and when its members presented him with a silver loving cup as evidence of their high personal regard for the many attractive traits in Dr. Roeber's character

It was during his sojourn in Philadelphia that Dr. Roeber found his real vocation Electrochemistry was growing so rapidly in importance that the need of an organ became evident. In 1902 *Electrochemical Industry* was started and Dr. Roeber was made its editor. The year following the office was removed from Philadelphia to New York. The journal rapidly gained in importance and influence. Its title in 1905 was changed to *Electrochemical and Metallurgical Industry*. In 1906 it absorbed the *Iron and Steel Magazine*. Finally, in 1910, it broadened its field, assuming the present title of *Metallurgical and Chemical Engineering*.

Throughout these fifteen years of journalistic activity he displayed the widest interest in general science and engineering, and a remarkable catholicity of knowledge. His writings showed a spirit of generous tolerance and a constant longing to be helpful and stimulating to others.

His circle of professional friends grew to be very large and his work was highly appreciated beyond the Atlantic. It bore the imprint of great ability and sterling character, coupled with an indefatigable love of work. It was, in fact, this willingness to undertake a variety of difficult tasks, and his high standard of conscientiousness in their execution, which led to the undermining of his vitality, when he seemed to be in his prime. For nearly a year he struggled with increasing weakness, until in June of this year he was forced to lay down the pen.

There seems to be no doubt but that the events in his native land contributed to the results of overwork. A thorough lover of his adopted country, a convinced believer in her mission in behalf of democratic ideals, like so many others among our loyal citizens born in Germany, he was forced to witness in silence the perpetration of crime after crime in his Fatherland, creating the deep, wide chasm which for decades hence will separate from the rest of the world the Germanic race.

It was a marvel to his friends that Dr. Roeber so rapidly attained the ability to express himself in English with such felicity and such force. His style was easy and attractive, thoroughly idiomatic, recalling the admirable editorial work in distinctly political fields of Carl Schurz, who fled from his native land at about the same age.

Dr. Roeber was actively identified with all organized effort to further American chemistry. In addition to the American Electrochemical Society he was an active member of the American Institute of Mining Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the Society of Chemical Industry, and the American Chemical Society and the Chemists' Club. In the latter he belonged to the Committee on Library and Art.

Dr. Roeber was married May 6, 1900, to Miss Clara H. Feir of New York. He is survived by his widow and three sons.

Apart from his professional work, Dr. Roeber was a notable figure in the social scientific life of New York. Bubbling over with enthusiasm, genial and sympathetic he attracted friends and admirers with singular ease. The number of those who will deeply miss him is exceedingly large.

Exemption of Chemists from Military Duty

In the inevitable haste required to organize the selection of the great army of American youth, now in training, and soon to be found on the firing line in Europe, we have not adequately profited from the experience of England and France. There, also, in 1914 was seen the same hurry to bring together with the least possible delay, every man capable or willing to carry a rifle. Ere long it was recognized that the engineer, the electrician, the chemist, and others of high scientific training, could render far greater service to the cause of national defense at home than in the trenches.

Then came the period, unfortunately after many had fallen, when they were gradually summoned back to deal with a multiplicity of problems of prime importance. Chemists in particular were required to handle all the questions involved in assuring an enormous output of explosives of every form, in combating the use of gases in warfare, in establishing the manufacture of drugs and general chemicals formerly secured from the enemy and in producing rapidly a host of articles essential for modern warfare.

On this side of the ocean there has been a tardy issue of regulations, exempting medical students and hospital internes. There has been, however, no action tending to free chemists from the action of the draft and save to the most vital industries of the land the men whose knowledge and training, now or later, will be of incalculable value for national defense or for preserving the integrity of our industrial fabric.

Dr. Wm. H. Nichols, chairman of the Committee on Chemicals of the National Research Council, has given this matter much thought in connection with his colleagues. At the recent meeting in Boston of the American Chemical Society he made the following forcible statement in depicting the activities of his committee:

"One of our most serious difficulties arises from the unwillingness of the military authorities to recognize the wisdom of exempting chemists as a class from the draft. Almost from the beginning of our work we took up this question from various angles, realizing as we do the vital importance of keeping chemists at work in their profession, not only at the present time, but more particularly for the future. Our civil, mechanical, electrical and other engineers can be made good use of at the front, and not only contribute greatly to the success of our forces, but by the valuable experience obtained in their profession can improve themselves for future service at home. This is not true of chemists, with an exception here and there. Once in the army and at the front, if he be only recently out of college, he is lost to chemistry forever. They are not slackers and are just as anxious as any other red-blooded young men to get into the fray, and therefore I have believed it wise not only to have them exempted from the draft but declined in case they should enlist. Already serious trouble has come to many of our chemical plants and plants employing chemists, as a result of the draft, and unless wise provision be soon made we can foresee a condition which it will cost months to rectify. Why should we not take advantage of the experience of our English friends who have passed through this same situation, and learned that there is a large class of men who can do more valuable work behind the lines than they can in the trenches?"

A Threatened Shortage in Sulfuric Acid

The manufacturers of artificial dyestuffs and of other synthetic coal-tar compounds are forced to face a new dilemma in addition to several others resultant largely from the abnormal demand for munitions.

This latest cause for anxiety is the threatened scarcity of sulfuric acid. It is due in part to the immense increase in the demand for acid, as a result of the rapid expansion of American chemical industry and of foreign requirements, chiefly, however, to the lack of raw material.

In the past large amounts of cheap Spanish pyrites, much of which had been treated and leached for its copper content, have been brought across the Atlantic at exceedingly low rates, practically as bal- submarine menace, these shipments have almost last. Under existing conditions, following upon the ceased.

It seems difficult to increase in any very material degree the current output of Louisiana sulfur or that of pyrites from American mines. Elaborate construction would be necessary in order to utilize upon a larger scale, than is the case at present, the roaster gases of our western smelters. They are also far removed from the region of intensive consumption, and there is the heavy handicap of the freight charges on the transportation of acids.

During the year ahead the consumption is expected to reach about 8,000,000 tons, and facilities for producing less than two-thirds of this amount are in sight. Quotations for sulfuric acid have reflected for months past the threatened shortage.

In the manufacture of coal-tar colors no other chemical is required in such amounts. Every operation of nitration requires an equivalent amount of sulfuric acid to act as a dehydrating agent. In the preparation of the many sulfonic acids, called for in rapidly increasing quantity, two molecules of H_2SO_4 are needed for every substituted HSO_3 group. It is evident that any serious lack of the acid will affect very noticeably the expansion of our color industry in regard to both cost of production and available supply.

Chemists are already studying how to economize in the use of sulfuric acid, as well as how to stimulate the production. There is a growing use of the free acid present in niter cake, or acid sodium sulfate, hitherto so largely disregarded. Much of the spent acid, resulting from nitration and ordinarily allowed to go to waste, can be recovered by employing proper means for concentration. This is being done on an increasing scale in England. Means have also been devised for recovering SO_2 from the flue gases of furnaces in which zinc blende is smelted. This recovery was highly perfected in German smelting works before the war and it could be profitably employed in this country. It would release a notable amount of sulfur now used in making sulfites for the paper industry and similar branches.

While we can trust to American enterprise and ingenuity to prevent any very acute shortage in the supply of the acid, it is probable that until the end of the war all consumers of sulfuric acid must count upon an exceptionally high price for their supplies.

Prospective German Competition in the Color Trade

Our American manufacturers of synthetic colors while losing no time in expanding the variety of their products, and co-ordinating all parts of their industry, are forced to consider at every point the possibility, or rather certainty, of the keenest imaginable competition after the war on the part of the great German firms, who have hitherto controlled the situation. Just how far the fairly generous protection for coal-tar products, contained in the Congressional enactment of September 8, 1916, will suffice, in many individual cases cannot be accurately estimated until the American maker is brought actually face to face with foreign competition. The effectiveness of the provisions to prevent underselling and unfair competition will be known only after the machinery is in genuine operation.

It is felt that in most cases the American producers of coal-tar colors and other synthetic preparations can confidently await the ordeal. The mechanism of manufacture will be practically standardized, and the all-important trade relations with the consuming public will have been established.

In some cases, however, the margin of safety may be quite limited. This is to be expected, more especially in the categories of colors in limited demand and of those the manufacture of which may be introduced very shortly before the return of normal exchanges. Our chemists will tend to measure more and more carefully the probabilities of an early peace as they undertake new problems and consider the factors of success.

The uncertainties faced by American manufacturers of dyes are, however, much less serious than those to which British colleagues are exposed. Thus far there has been no attempt to enact at London the protective legislation regarded as absolutely necessary to ensure the healthful growth of a domestic color industry, at least during the initial years. The great complexity of the problem is fully recognized and is attracting general attention. Some of the many factors involved were considered recently in an article in the Manchester *Guardian*, from which the following extract may be of interest to American manufacturers:

"The supplying of all the varied needs in dyestuffs of every trade is a bigger affair than most people conceive. Can we undertake to supply, for example, the hatting trade with just the blacks they require for their fur felts, or the calico printers with a complete range of fast and easily dischargable colors for lining styles, or the worsted cloth manufacturers with a black which will withstand their 'potting' process? Possibly these, which are taken at random, and yet not others, for the difficulty is not one of bulk but of variety. In certain directions we are still held back by lack of raw material, and here we may expect immediate improvement with peace. Then also we may look for a rapid ripening to production of much patient research. We may even expect to be well supplied with azo colors for both wool and cotton; but here, and more inevitably in other directions, there will be gaps which will be at least awkwardly felt by almost every branch of the coloring trades.

"Undoubtedly, however, the English dye manufacturers will have as an asset the prevailing anti-German prejudice; nor is it likely that prices will immediately drop to unremunerative levels. There will be no 'dumping,' for, as the German trade journals testify, there is no accumulation to dump and no incentive to sell at cost when high prices tempt German production into every other civilized country. What may be anticipated, however, is a very considerable modification of the former German methods of propaganda.

"It will be worth our while to consider those insidious propagandist methods of the German colormakers from the point of view of a British dyer of good standing. In pre-war times he was assured by experience of a conscientious regularity in shade and strength of consecutive deliveries, and supplied with a great number and variety of tasteful pattern cards, illustrating complete ranges of dyes suitable for his own branch of trade or new dyes which might be of interest to him, with full details of fastness and methods of application. Some of these were really valuable books of reference, and were said to have cost half-a-guinea a copy to produce. The pattern card departments of the large firms were very completely equipped."

Prospective Competition of Japan in the Manufacture of Dyestuffs

With each passing month the ability of Japan to build up a varied chemical industry is becoming more and more evident. The same conditions favor its growth which are now stimulating so marvelously the expansion of the American chemical industry. There is the same insistent domestic demand, the same flood of inquiries from various lands, all seeking to secure supplies which hitherto have come in abundance from Europe, and more particularly from Germany.

Japanese chemists have utilized the situation quite as promptly as has been the case in this country. One branch after another has been organized and brought into effective operation. In some instances, notably in regard to the prussiates and potassium chlorate, the output has already out-distanced the local needs and the product is seeking foreign markets.

The question naturally arises, to what extent may this affect our growing American industry, when normal conditions are restored, and especially our coal-tar chemical industry.

At present our domestic consumption eagerly absorbs all of the prussiates and potassium compounds which Japan can send us, and pays good, round rates for the same. There is a feeling in the Island Empire that these conditions may continue indefinitely, and that numerous other chemicals may be included in the list. This confident expectation is based largely upon the existing cheapness of manual labor, the daily wage of Japanese operatives averaging about 50 cents in gold.

It is doubtful, however, whether the Japanese chemical industry, with this unquestioned advantage, can hold its own in competition with highly organized European and American industries.

In most branches of technical chemistry, the labor cost is a minor item in the budget of a factory. The prices of raw materials, of fuel, of electric power, of transportation to markets, are controlling factors. Most of these elements of cost are quite as high for the Japanese producer as for his American competitor. He faces, in addition, an American tariff.

The natural resources of Japan are not of a character to form the foundation of a well-balanced chemical industry. Most raw materials must be imported. It is true that China, with her inexhaustible coal deposits and many other mineral and organic products, is close at hand, and at the same time, offers a market for a vast amount of chemicals and dyes.

Japanese chemists have shown great ingenuity and perseverance in securing notable quantities of potash and iodine, as well as of other substances from the kelp of the Pacific, but apart from this feature they are heavily handicapped. The metallurgical industry is but slightly developed and the coking plants are few. Any material expansion of the recently started dyestuff industry would involve dependence upon this country or other sources for the raw material.

Under these circumstances it is extremely improbable that Japan may count as a serious factor in the future of our dyestuff industry. Her chemists are still dealing with elementary problems, and are not yet as far advanced in coal-tar chemistry as were scores of American chemists when the world war broke out. They display commendable pluck and energy, and undoubtedly will create a domestic industry fairly adequate for their country's needs. When the time comes for expansion, it would seem as if China will be the natural field for their operations. The market is at their doors and presumably they will depend to a considerable extent on Chinese coal. China already consumes large quantities of artificial colors, and is, in fact, the chief consumer of synthetic indigo. With the rapid opening of the republic to modern industrial ideas and practices, its vast population will constitute, ere long, a market of enormous consumptive possibilties.

As normal trade relations return we may, therefore, witness rather an opening in Japan for much of the excess of our chemical output, than any pronounced movement in the opposite direction.

At the same time we may confidently expect that the Japanese color industry, aided by its governmental subsidy, will soon reach the point where it will effectually meet the nation's demands. There will be but a limited opportunty for dyes of American or even German make, and Japanese products may meet us competitively in the adjacent markets of the Far Orient.

Dr. Johnson Commissioned.

Dr. James J. Johnson, expert on high explosives, formerly chief chemist for the Maas & Waldstein Company, has received a commission as captain in the Ordnance Department, U. S. A. He will serve in the gun division.

Phio Color Works.

Dyestuffs and allied products will be manufactured by the Phio Color Works, New York, which was recently incorporated in that state with a capital of $5,000 by L. W. Alexander, F. C. Simons and M. Winters, 595 Eastern Parkway, Brooklyn.

American Coal-Tar Products Industry Production To Be Ascertained by the United States Tariff Commission.

The United States Tariff Commission is planning to ascertain the production within the United States during 1917 of all substances treated in Title V of the Special Tariff Act of September 8, 1916. The substances there enumerated may be classed under the general Coal-Tar Products, and are divided into three groups.

Group I includes "all products that are found naturally in coal-tar, whether produced or obtained from coal-tar or other source" except phenol. These substances are admitted free of duty.

Group II includes the so-called Intermediates and are made dutiable at 15 per cent. plus 2½c. per pound.

Group III includes "all colors, dyes, or stains, whether soluble or not in water, color acids, color bases, color lakes, photographic chemicals, medicinals, flavors, synthetic phenolic resins or explosives, not otherwise specially provided for in this title, when obtained, derived or manufactured, in whole or in part from any of the products provided for in groups I and II." These articles are dutiable at 30% plus 5 cents per pound with certain exceptions which are dutiable at 30%.

Under the law the duties are made dependent on the growth of the industry within the United States. It is therefore the intention of the Commission to follow this growth from year to year in order to report the facts to Congress.

The Tariff Commission is planning to send to each manufacturer a questionnaire calling for information in regard to his production during 1917 of each separate commodity, as well as for certain other data. This information will be published in such a form that the operations of individual firms will not be disclosed. A preliminary questionnaire has recently been sent out, designed to aid in perfecting the mailing list. Any individual or firm engaged in the manufacture of any of these articles which did not receive a copy of the preliminary questionnaire is requested to write to the United States Tariff Commission, Washington, D. C., to insure being placed on the mailing list.

COAL-TAR CRUDES

Crude Benzols

One great difficulty in solving the problem of the production of benzol and toluol by carbonization of coal has been the lack of a rapid, simple and reliable test for the benzol content of the gas and of the crude benzol produced. P. E. Spielmann and G. C. Petrie, in the July 31 issue of the Journal of the Society of Chemical Industry, give some interesting figures obtained from nine coke-oven benzols analyzed by recent methods compared with simpler operations that are suggested by the authors. A preliminary distillation up to 170° C. was made, determining the per cent. of distillate, its specific gravity, loss after treatment with NaOH and H_2SO_4, and after subsequent steam distillation. A fractional distillation was also made, the per cent of distillate up to 90°, and from 90° to 140°, composition of these fractions expressed as per cent benzene, toluene, xylene, paraffin, carbon bisulfide and residue being determined. The volume per cent of distillate under 120° by the retort and the distillation tests and the specific gravity of all fractions, were found.

When curves are plotted showing percentage of distillates at the various temperatures up to 170° for the preliminary distillation, the horizontal distances between 5% mark and the point where the curve cuts the 92.5° C. line give a close measure of the percentage of the benzene present while the quantity of toluene is proportional to the number of millimeters of maximum deviation of the experimental curve from the smoothed curve shown dotted on the graph. The percentage of liquid obtained by distillation up to 120° is very closely approximate to that of the washed liquid boiling up to 140°. By means of a plot or graph it is shown that the specific gravity of the portion fractionated up to 170° correspond fairly well with the quantity to 140°, and the per cent loss on acid washing plotted against the quantity of the three components benzene, toluene and xylene found in the distillate up to 170°, seems to show that the two main constituents occur in inverse connection with one another and that combined with the xylene, the total aromatic substances in the fraction up to 170° show a remarkably constant inverse relationship to the loss on acid washing.

A preliminary distillation therefore up to 170° C., noting the volume of distillate at 120° and at 170°, the specific gravities of the fractions, and the per cent loss on acid washing, will, when plotted as described, furnish valuable information.

The Tar Industry of Great Britain

In the report for 1916 of the British Alkali Inspector there are interesting surveys of the extent and character of the tar industry, which has expanded rapidly of late as a result of the pressing demand for raw material in the manufacture of high explosives. We quote the following:

"The number of tar works registered was 316, as compared with 248 in 1915, a difference of 68. This large increase was almost entirely due to the rapid extension of the use of tar-dehydrating plants in gasworks. Those plants designed to effect continuous distillation were very widely adopted. In some cases, however, simple plants were erected at a much more moderate cost which gave quite satisfactory results. In several districts plants designed upon the continuous system were not provided with sufficient condensing power. This is a serious fault, as not only did it lead to an escape of objectionable vapors, but to a loss to the country of an unknown quantity of benzol and toluol at a time when every effort should have been made to conserve these to the utmost for munition purposes.

"Whilst it may be to the interest of individual gasworks proprietors to provide small tar-dehydrating plants, it is of doubtful advantage to the community to have numerous small units for treating tar put into operation without specially skilled supervision to ensure such plants being worked to their full advantage. Plants of faulty design, apart from inefficient condensation, have been put into operation which must have affected prejudicially the quantity of products obtained. In the works of experienced tar distillers or in factories worked under skilled supervision through co-operation of a number of conveniently situated gasworks, it is unlikely that such plants would have been put into operation without modification. Combined effort with high efficiency through skilled control will always beat individual effort with variable efficiency and often devoid of specialized control.

"The means in use for preventing the escape of noxious gases underwent no change. Apart from the temporary undue escape of vapors of volatile hydrocarbons, due to insufficient condensing plant, these works were conducted satisfactorily as regards the requirements of the Act.

"The quantity of tar operated on in the United Kingdom was as follows:

Tar distilled in—	Long Tons
Gas works	1,420,867
Other works	138,552
Pitch produced in—	
Gas works	715.051
Other works	83,690"

Distillation of Tar Oils.

An Australian inventor, W. R. Grimwade, of Toorak, near Melbourne (Br. Pat. 108,004, of 1916), has devised a method to obviate the objectionable odor clinging to phenol, the cresols and other tar oils, obtained by the distillation of coal tar. He claims that it is due to the presence of oxygen in the still, during the operation of distillation, and remedies the difficulty by maintaining in the still an atmosphere of inert gas, such as carbon dioxide, nitrogen, or simply flue gases. The non-oxidizing gas is introduced through a pipe terminating slightly above the floor of the still.

Control of Coal Tar in Great Britain.

After Oct. 1 all transactions in coal tar throughout the United Kingdom can take place only under license from the Ministry of Munitions. Every effort is being made to assure an adequate supply of benzene, and especially of toluene, for use in the manufacture of high explosives.

COAL-TAR INTERMEDIATES

The Manufacture of Anthraquinone

There is a growing feeling that our American color industry should promptly enter upon the manufacture of alizarin and the other important dyes derived from anthraquinone. In this connection we reproduce from "La Revue Produits Chimiques" a full account of the current process, now employed in Europe, for transforming the hydrocarbon anthracene into anthraquinone:

By oxidation anthracene yields anthraquinone according to the equation:

$$C_{14}H_{10}+3O=C_{14}H_8O_2+H_2O.$$

As this oxidation is effected industrially by means of chromic acid it may be formulated as follows:

$$C_{14}H_{10}+Na_2Cr_2O_7+4H_2SO_4= C_{14}H_8O_2+Cr_2(SO_4)_3+Na_2SO_4+5H_2O.$$

It is performed in large wooden vats, lined with lead, holding 10 to 12 cubic metres. The vats are heated with direct steam and furnished with agitators. A vat is charged with sumblimed anthracene, still in form of paste. The charge is 150 kilos of anthracene to 3,000 to 4,000 litres of water. The temperature is raised to 75° C., and, with constant stirring, 2,000 litres of a chromic solution, containing 100 grammes of chromic acid and 250 to 300 grammes of sulfuric acid at 66° Bé. per litre, are added gradually. The 2,000 litres, therefore, contain 300 kilos of bichromate of soda and 600 kilos of sulfuric acid. During the operation the temperature gradually reaches 95° C.

The oxidation is carried on for twelve to sixteen hours, and does not present any particular difficulties. The chromic acid must not be added too quickly, and the solution must not be too concentrated. Otherwise a persistent and troublesome foam is produced. The reaction is controlled, from time to time, by testing samples. A sample is filtered, washed, then sublimed over the naked flame in a small test-tube, and, with a little practice, it is easy to see if the anthraquinone is pure or whether, on the other hand, there is still anthracene present.

The anthraquinone sublimes in fine needles, whereas anthracene forms silvery scales, easily recognizable.

It will be seen by the proportions given that the bichromate is employed in excess; 200 kilos of bichromate, theoretically, should be able to oxidise 175 kilos of 95 per cent anthracene.

When the oxidation is terminated the contents of the vat are forced by a pump through a filter press, in which the anthraquinone is thoroughly washed. If the anthracene used is sufficiently pure, the yield is about 110 per cent of anthraquinone.

The anthraquinone thus obtained is sublimed by steam is an apparatus similar to that used for anthracene. On the sublimation the weight is reduced; the theoretical 117 per cent falls to about 80 to 85 per cent.

Formerly, when non-purified anthracene was oxidised, the anthraquinone obtained was very impure, and had to be treated with two or three times its weight of sulfuric acid (66° Bé.) at 100° C., until a sample poured into water gave an almost white precipitate. By this treatment the impurities became soluble in water, whereas the anthraquinone, being insoluble, could be separated out. Since purified anthracenes have been obtainable, this operation has disappeared, sublimation alone being generally sufficient to bring the anthraquinone to a sufficiently pure state for ordinary purposes. The sulfuric acid treatment is still resorted to, however, in the rare cases when an extremely pure anthraquinone is required.

Anthraquinone forms yellow crystals. In a finely divided state it is almost white. The fusing point is 284.6° C., the boiling point 382° C. It sublimes very easily. It is completely insoluble in water, slightly soluble in alcohol, ether, and benzene in the cold, rather more soluble with heat in benzene and in glacial acetic acid.

It is not a commercial product. Apart from a limited use as catalyser in certain sulfoxylate discharges, it is employed solely in the color works.

It is interesting to note that it may be synthesized without using anthracene as the point of departure. Phthalic acid is condensed with benzene in the presence of chloride of aluminum. This gives ortho-benzoyl-benzoic acid. By anhydrisation with hot concentrated sulfuric acid this gives anthraquinone. The reaction is so simple that its industrial application has been considered. As a matter of fact, although it has not been used for anthraquinone itself, it is employed in the synthesis of different derivatives of anthraquinone.

A very important factor in the economy of anthraquinone manufacture is the regeneration of the chrome, which, after oxidation, is in the state of chromic sulfate. This can be crystallised and recovered in the form of chrome alum, after the addition of the necessary quantity of sulfate of potash or of sulfate of ammonia, as the ammonia alum crystallises as well as the potash salt.

The high price of chrome alum, which is very largely used at the tanneries, makes the recovery of importance. An annual production of 300 tons of anthraquinone nearly corresponds with the French consumption, and in the manufacture 1,500 tons of chrome alum are obtained.

Another way is to precipitate the chromic sulfate with soda, which gives chromium hydroxide used in the preparation of chromium acetate, chromium fluoride, and other salts used in the textile industries. In the German works the chromic acid is recovered by electrolysis, which is by far the most economical way where the electric current is cheap.

Uses.

Except for certain special purposes, anthraquinone serves almost solely as the raw material for the anthraquinone colors, of which alizarin is the most important. By sulfonation, nitration, chlorination, and other processes nitro-anthraquinone, sulfo-anthraquinone, chloro-anthraquinone, amido-anthraquinone, etc., are prepared, and these serve as intermediaies for the manufacture af a large variety of valued dyes.

A New Class of Anthraquinone Intermediates

Paul Nawiasky, of Ludwigshafen-on-the-Rhine, Germany, assignor to the Badische Anilin & Soda Fabrik. (Amer. Pat. 1,238,932, of Sept. 4, 1917), has invented a new class of anthraquinone derivatives, which promise to be of value as intermediates in the manufacture of colors. The method of production consists in reacting on an anthraquinone-beta-sulfonic acid body with an amino compound of the benzene or naphthalene series, in the presence of strong alkali, until the sulfonic acid residue is split off.

The new compounds of the anthracene series are anthraquinone-beta-arylides of the formula:

A—NH—R.

A represents an anthraquinone residue, free from SO_3 groups. R represents an aromatic residue containing less than fourteen carbon atoms. The operation is preferably carried out in the presence of air or of a solid oxidizing agent such as potassium chlorate.

These anthraquinone-beta-arylides are insoluble in water, dilute acids and alkalis, soluble in organic solvents and in concentrated sulfuric acid. The solutions in the latter turn, when heated, into blue or bluish violet. When treated with sulfonating agents, they yield wool dyes with good properties.

The following example illustrates the process of manufacture:

Heat one thousand parts of aniline to the boiling point. After any water that may have been dissolved therein has been distilled off, add thirty parts of powdered caustic soda and one hundred parts of anthraquinone-2-sulfo acid sodium salt. Keep the mixture boiling for about five hours, preferably while well stirring, and passing an ample current of air through the mass. After cooling, remove the excess of aniline by dissolving it in dilute hydrochloric acid and extract the insoluble residue with dilute alcohol. Dry it and recrystallize, for instance, from chlorobenzene. The red crystalline needles, thus obtained, are 2-phenyl-amino-anthraquinone. They melt at 234° to 236° C.

Other salts, or derivatives, of anthraquinone-2-sulfo acid, or the free acid, can be used instead of sodium salt, for instance, the aniline salt, or the anilide. Instead of aniline other amino compounds of the benzene or naphthalene series can be employed. Para-toluidine yields 2-para-tolyl-amino-anthraquinone in the form of crystals melting at 234° to 235° C. Para-chloro-aniline yields 2.4′-chloro-phenyl-amino-anthraquinone, crystals melting at 302° to 303° C. Aniline and 2-chloro-anthraquinone-7-sulfo acid sodium salt yield orange colored needles of the corresponding anilide which melt at 276° to 277° C.

Picric Acid Works in Great Britain

The report, for 1916, of the official charged with the inspection of the British factories for the manufacture of picric acid shows that much is being done to restrict the damage due to the escape of nitric fumes, but that much remains yet to be done. The following extracts are of interest:

This class of works increased in number, all the new factories being of important productive capacity. Large extensions also were carried out in factories already in operation.

The treatment of waste fumes in this class of works still leaves much to be desired. The volume of these has grown with the increased scale of operations. Advance has been made in some of the factories by collection and condensation of the objectionable discharge, but in many cases much yet requires to be done in this respect.

Various influences have adversely affected progress in dealing with the fumes evolved in these works:—difficulty in obtaining the necessary earthenware appliances—partly through limited production, and partly through the large demands for material of the kind required to equip new productive plant for picric acid manufacture. An explosion, which led to the destruction of an extensive plant, not only made increased calls for material to make good the destruction caused, but led to the most regrettable loss of the life of one who was taking an active part in bringing into operation an efficient fume-recovery system.

Improved methods for reducing working losses of picric acid and for the recovery of the waste acid remaining from the process—a question of prime national importance—took up part of the attention of the management, as well as much of the labor available at the works.

In those cases where definite progress has led to practical results much improvement has been effected. Not only were the noxious fumes effectually dealt with, but the conditions of manufacture were better under control, resulting in greater yield of high-quality product and decreased consumption of material, whilst the capacity of production of plant was increased, when compared with operations under the previous conditions.

Complaints were made, and made with justification, against some of these works in which it was difficult to effect rapid improvement under the unusual circumstances, but an early advance in fume treatment is now looked for.

Serious Explosion in Munitions Plant

The most serious accident that has happened in any American chemical plant since the making of munitions was started, occurred at the works of the Curtis & Harvey Company, at Rigaud, Que., on August 18. The marvel was that with two hundred and fifty men working in and around the buildings and a total of four or five thousand hands employed by the company, so few fatalities resulted from the fifty explosions which followed the first. While several were injured, only one man, so far as reported, was killed, and this was an expert who had been brought out from England as foreman of the works. The loss in material, buildings and plant is estimated at $2,000,000. The village of Dragon, some distance from the works and containing about forty houses, was practically wiped out by the explosions and the fires which followed, and tons of metal were hurled around the country for nearly a mile. For example, a piece of boiler plate weighing over a ton was found half a mile away, and it is remarkable that none of these fragments killed any of the inhabitants. Two farm houses more than a mile away were blown down. Through the heroism of a telephone operator, a rescue train was called from Montreal and was soon on hand.

Though the cause of the accident will probably remain obscure it is fairly certain that it was due to some omission or carelessness in the operation of the plant. At the coroner's inquest, George Dufresne, the foreman in the nitrating department, said that he had been working in the plant since December and had had no previous experience in the making of trinitrotoluol. At 9 A. M. he had noticed that No. 6 nitrator was acting strangely. He explained that there were six large nitrators in the plant, 12 feet deep by 9 feet in diameter, which were used to agitate the toluol and the nitre and sulfuric acid. At the time of the accident, two were empty and four were filled. The charge in No. 6 had been finished and the contents were ready to be emptied through a pipe into another tub, where the acid was separated. "I saw white smoke coming out through the cover," said Dufresne. "This was followed by fire, and I knew then that everything was going. There were nine men in the plant, and I told them to run for their lives. I sent two men to warn the others. The explosion soon followed." Witness said that there had never seemed to be any defects in the vats other than what could be immediately corrected. There was no possibility of the explosion being caused by outside interference, as no outsider was allowed to look into the nitrator. Timothy Curtis, vice-president and general manager, said that in the ordinary course of events the material did not offer any danger. There was danger in case the acid got too hot, but the principal danger was from the acid fumes. He thought the fire was caused by spontaneous combustion through the decomposition of the chemicals.

The reconstruction of these works depends on contracts to be concluded with the United States government.—The Canadian Chemical Journal.

Catalytic Synthesis of Aromatic Substitution Products

Frederick G. Keyes, of East Orange, N. J., assignor to the Cooper Hewitt Electric Company, of Hoboken (Amer. Pat. 1,237,652, of Aug. 21, 1917), has devised new methods for stimulating various synthetic reactions, especially in the aromatic series, which under ordinary conditions take place sluggishly or not at all.

In carrying out the process use is made of certain energizing means such as electrically excited quartz tubes containing mercury vapor for producing radiation by electrical means.

The process is especially applicable in the case of substituting halogens for hydrogen in the methyl groups of toluene, xylene, etc. For example, to produce dibromo-xylene, bromine and xylene are mixed and under agitation exposed to the effect of the radiation from a quartz mercury vapor tube which catalyzes the reaction with a copious evolution of gaseous hydrogen bromide, the dibromo compound remaining behind. This process proceeds ordinarily only in sunlight and then very slowly. By use of the radiation from a quartz lamp, catalyzing takes place with tremendously greater rapidity and certainty.

Various convenient forms of apparatus for the purpose are described. Tubes of quartz surrounded with vacuum jackets and provided with agitators are especially valuable. In these it is possible to subject a reaction mixture to actinic rays from a source which generates more heat than desired for the reaction and protect the mixture from undue heating by the aid of a vacuum chamber.

Catalytic Production of Aromatic Amines

Otto Schmidt and Hugo Blankenhorn, of Mannheim, Germany, Assignors to the Badische Anilin & Soda Fabrik (Amer. Pat 1,237,828, of Aug. 21, 1917), have perfected a method for the catalytic manufacture of aniline and its homologues, which is, apparently, a notable simplification of the current processes for the reduction of aromatic nitro compounds.

It consists essentially in treating the substance to be hydrogenated, in the presence of a contact mass, with a mixture of water gas and at least one volume of water vapor, for each three volumes of the carbon monoxide present. Gases containing carbon monoxide and hydrogen, such as water gas, or Dowson gas, may also be used in the presence of water vapor, the reducing action of the hydrogen being increased by the simultaneous action of carbon monoxide and water vapor. The process renders it possible to substitute for hydrogen cheap carbon monoxide or the still cheaper mixtures containing it.

Hydrogenizations of the most varied kinds can be carried out by this process and the reaction takes place at comparatively low temperatures.

The transformation of nitrobenzene into aniline is effected as follows:

A vertical cylinder is supplied with a contact mass containing copper, such as is obtainable by coating 130 parts of pumice stone with a mixture of 24.3 parts of cupric carbonate, 2.7 parts of zinc carbonate and 20 parts of a concentrated sodium silicate solution and reducing at a low temperature. Through this cylinder is passed a mixture of vaporized nitrobenzene and an excess of a reducing gas, containing carbon monoxide and water vapor, in such a proportion that at least one volume of water vapor is present for each three volumes of carbon monoxide. A temperature of 200° to 220° C. is maintained during the reaction. The output of aniline, thus produced, is very satisfactory.

Manufacture of Trinitrotoluene.

Ferdinand Quartieri, an Italian chemist, of Milan (Amer. Pat. 1,241,017 of Sept. 25, 1917), finds that trinitrotoluene of exceptional purity can be secured if the crude dinitrotoluene obtained by gradual nitration be purified before proceeding to the final nitration. For this purpose the solid crude dinitro compound is submitted to a partial and fractional liquefaction. The resultant liquid, containing the impurities present, is removed and nitrated separately to produce a new amount of crude dinitro body. The residual purified dinitro-toluene is nitrated at 110° C., and yields a very pure trinitrotoluene. After slow crystallization, washing with water and removal of volatile impurities by heating in a vacuum, it possesses a melting point of 80.5° C. All necessity of recrystallization from volatile solvents is obviated by this method.

ARTIFICIAL COLORS

Reinstatement of the Dyestuff Industry in England.

By Professor Arthur G. Green.

Professor Green, the leading color chemist in Great Britain, has recently published a careful analysis of the dyestuff situation in England, and of the conditions requisite for the successful expansion of the industry and its permanent continuance after the war, which is full of valuable suggestions for those engaged in creating the American industry. Emphasis is laid upon the imperative necessity of favoring legislation if the British industry is to cope successfully with that of Germany later on. In this respect the American color manufacturer is fortunately well protected by the Congressional enactments of Sept. 8, 1916. Another point brought out by Professor Green is the necessity of having trained chemists among those in responsible charge of color industries. Here, also, it can be claimed that the leading factors in the American industry are making the right start.

The very considerable progress which has been made during the war toward the establishment of the British dyestuff industry upon a larger and firmer foundation, lends support to the hope that our lost prestige in this important industry may eventually be repaired. At the same time it is essential that we should not take a too optimistic view of the situation.

In this industry the possession of large capital, though of importance, is only a secondary asset. What may be termed the "intellectual capital" of the firms has by far the greatest value. Although, through patents and other publications, most of the manufacturing processes, so far as relates to their principles at least, are known to all, it may be safely asserted that not 1 per cent of such processes, if carried out strictly as described, would be capable of meeting competition under normal conditions. A deficiency, for example, of 5 to 10 per cent in the yield would be enough to make competition impossible. To work out so many processes in detail involves immense staffs of research chemists, and the formation of such staffs is the first task.

It is stated that the combination of the three German dyestuffs firms—Badische Aniline Company, Farbenfabriken, Elberfeld, and Berlin Aniline Company—employed in 1912 over 700 qualified chemists, mostly of university education. The preeminence of Germany in the organic chemical industry has been secured, not so much by the brilliant discoveries of a few men of outstanding originality and genius, as by the organization of armies of research workers, ready to carry out the ideas of their directors and to investigate in every possible detail any new reaction which may have been discovered. To establish the color industry in this country on a footing commensurate with that of Germany and able to compete with the latter in the free markets of the world will eventually necessitate the chemical staffing of our works on a similar scale. How shall we obtain these men? The number of organic chemists at present turned out from our universities and technical schools is very inadequate, the unpromising career offered in the past by the English dyestuff and other chemical industries having discouraged many men of ability from entering the chemical profession.

In the attempts which have been made during the war to stimulate the dyestuff industry by government assistance the mistake has been made of regarding the matter as a purely financial one. It was thought by those who had the direction of the project that a large dyestuff industry could be established in the country by the same method as might be adopted to put up a new cotton mill or to build a steel works; viz., to provide sufficient capital for the undertaking, for a board of directors consisting of business men having no expert knowledge, and leave them to engage the necessary chemists and engineers. Such a method, however, cannot succeed with the dyestuff industry, in which it is of paramount importance that the scientific direction should be at the top, and that science should not be merely employed as a hand-maiden to wait upon business. It can readily be demonstrated that the success attending the large German works was largely due to the fact that their chief directors were themselves men of good chemical and general education, and that not only the technical, but to a large extent also the business, policy of the firm was administered by chemists.

It would be easy to mention several of Germany's best known business men who are chemists by education and profession, and this should controvert the prevalent fallacy that a scientific training is a bad preparation for a business career. This system made for a wider outlook and enabled the leaders of the industry to take a longer view. They brought a degree of scientific imagination into business which enabled them to see beyond immediate financial returns to a more distant period when the bread which they had passed upon the waters would return to them tenfold. Whatever we may think of German business methods in other directions, the far-seeing policy of these men is worthy of the greatest admiration and imitation. In following the rise or subsequent decadence of the dyestuff industry in our own country, it is interesting to observe that a connection may be traced between the prosperity of the industry and the extent to which it was under chemical management. The English works, like the German, were originally founded by chemists, but in most cases the management, for one reason or other, subsequently passed into the hands of purely commercial men. Coincidently with this change the fortunes of the respective firms began to decline. To take a single example, with the history of which the writer is especially familiar: The firm of Simpson, Maul & Nicholson (the predecessors of Brooke, Simpson & Spiller) was founded and managed by E. C. Nicholson, a chemist of remarkable power and ability. Upon his retirement the business was bought by Messrs. Brooke, Simpson & Spiller, only one member of which firm was a chemist. After a short period of great prosperity, due to the pre-occupation of Germany in the French-German war, the business began to decline. During this period of temporary prosperity, in which enormous profits were earned, no attempt was made by the firm to provide for the future by engaging more chemists or by the establishment of larger research laboratories.

On the contrary, the business was awakened by the withdrawal of all the profits made, so that on the return of the German firms to active competition the business began to go down hill rapidly. Even the discovery of a number of important new reactions and new dyestuffs within the firm's laboratories did not avail to save them from decadence, for their commercial and unscientific management was so incapable of seeing the value of any innovation that they refused to take advantage of their own chemists' discoveries, which, in consequence, only served to benefit their German competitors, who so quickly made effective use of them. As examples may be mentioned the late Professor Meldola's discoveries of the preferential reduction of the nitro group in azo compounds as a means for preparing diazo dyestuffs; his discovery of fast blue, the first dyestuff of the oxazine series; the writer's discoveries of the primuline dyestuffs; the fixation of colors on the fibre by diazotization and coupling, and the yellow dyestuffs subsequently known as thiazol yellow and thioflavine T. These and other discoveries, the importance of which the German firms were quick to recognize, were made in the Hackney Wick laboratories between the years 1878 and 1888, but, through the absence of expert chemical knowledge in the directorate, brought neither profit to the firm nor encouragement to the inventor.

I think we may congratulate ourselves on the fact that in Manchester at least the rejuvenated industry is in no danger of suffering from this fault.

The position of the dyestuff industry of the world after the conclusion of peace is a difficult one to forecast. On the one hand, the German firms have by means of their big production of explosives strengthened their financial position and increased their dividends. On the other side, their plant must have been greatly disorganized and their staffs depleted by the war, and it will be some considerable time before they can again be brought to their previous state of efficiency. Further, whilst on one hand the world's stocks of dyestuffs have been largely exhausted and a free market will exist for a time, this will be of a temporary character only, as the permanent markets for German products will be greatly restricted, owing to the growth of competitors in all large industrial countries. The position is also complicated by the fact that in England, France, and America enormous explosive works have arisen which look to the manufacture of intermediates for dyestuffs as an outlet for the employment of their plant and organizations after the war. As, however, most of these plants are only adapted for the manufacture of a few products, such as nitrophenol, dinitrotoluol, aniline, toluidine, etc., and the quantities of these materials which they could produce would enormously exceed the demand, a large over-production of such products seems inevitable, and the largest of such concerns may therefore seek an outlet for their productions by themselves entering the dyestuffs arena.

It is obvious that the difficulties under which the English dyestuff industry must labor for a time can only be met by some measure of State assistance. Whether such assistance should take the form of an import duty, of a direct subsidy to the producer, or in a complete or partial prohibition upon imported dyestuffs, is a matter open to great differences of opinion, and one which I do not propose to discuss here. Without such help, however, during its period of growth, the reinstated dyestuff manufacture cannot establish a satisfactory position, even although, as may well be the case, the German industry does not regain its pre-war efficiency for several years.

The enormous importance of dyestuff manufacture to the country, which the war has demonstrated, will have convinced everyone that whatever means be adopted, this essential industry, with which so many other trades are inter-related or dependent, must never again be allowed to languish.

Japan's Purchase of American Dyes.

It is reported that the Japanese Government, at the end of September, purchased from the National Aniline and Chemical Co. artificial dyestuffs, valued at over $500,000. Immediate delivery was stipulated and within three days after closing the contract a large share of the colors started on their voyage westward. Prices ranged from $1.50 to $3.50 per lb. This is stated to be the largest individual sale of coal-tar colors ever made in the American market. It speaks volumes for the swift expansion of the American dyestuff industry that such a transaction could take place at this date. Probably a large share of the colors sold are blacks. It has been evident for some time that the point was being approached at which the output of black dyes in our works was not far removed from the current demand. In the matter of vegetable dyes, it has been possible for over a year past to ship abroad enormous amounts of these colors, without materially curtailing the quantity required in our domestic industries.

The Revival of the French Dye Industry

In a pamphlet written by M. Henry le Wita, and recently published at Paris, the author refers first of all to the great decline in the French chemical industry in general and the dye industry in particular. At the beginning of the 19th century France was well prepared for industrial developments. She had a brilliant group of scientists, headed by Lavoisier and his school, whose researches were of inestimable value to the French chemical industry. Subsequently, however, manufacturers were content to rest on their laurels, and supremacy in the chemical trades quickly passed to France's neighbors, notably Germany. Notwithstanding the latter country's concentration on the industrial applications of chemical science, the author points out that pure science was by no means neglected; on the contrary, it was regarded as supremely essential. The author gives fifteen reasons for the great success achieved by the German chemical industry. Practically all these reasons are now, after three years' war experience, sufficiently obvious and need not be repeated.

In the second chapter of his pamphlet, Le Wita points out that, despite innumerable speeches, addresses, and lectures, no action was taken in France to remedy matters until recently, when the French National Dyestuff Company was formed in Paris with a capital of 40,000,000 francs. This action followed the delivery of a lecture at Lyons by the French Minister, Denys Cochin, in February of the present year. The author also describes the energetic measures taken by the German dye trade to meet after-war conditions and the consequent formation of a gigantic combine with a total capital of three to four hundred million francs. In order to counter these measures on the part of Germany it is necessary, the author thinks, to refrain from any commercial relations with Germany and to manufacture as much as possible at home. The French National Dyestuff and Chemical Company requires, among other essentials for success, a Board of Directors containing real live men of affairs having a thorough knowledge of pure and applied science, also a complete absence of petty jealousy and friction in its working. One of the things which the company will have to undertake immediately is the working of the German dye factories in France, which have now been sequestered.—The Chemical Trade Journal.

The Swiss Dyestuff Industry in 1916

A report from the American Consulate at Basel furnishes some interesting data on the status, during 1916, of the Swiss color industry, which is confined almost entirely to the large works located in that city:

"There was a decrease in exports of aniline colors to the United States in 1916 amounting to 78,522 pounds, or 6 per cent, and an increase in value of $1,124,031, or 113 per cent. This was due to the general advance in prices and to the exclusive shipment of the finer and more expensive colors. The progress made in the American color industry practically excluded the lower grades of Swiss dyes from that market. Anxiety was felt in Switzerland concerning the future trade in Swiss colors with both the United States and England. The belief that those countries would not be able to produce aniline dyes was disproved. Since 1914 dye factories have also been built in France, Italy, and Russia. It became more and more difficult in 1916 to obtain necessary raw materials from England and the United States. Another cause of alarm to Swiss color manufacturers was the merger of two large groups of dyeworks in Germany with a joint capital of $230,000,000, with the object of capturing neutral markets after the war. The Swiss manufacturers are now preparing to withstand the apparently concerted effort of German color manufacturers to undermine the Swiss dye industry.

"To meet their immediate needs in raw materials, not provided for under an agreement with the British Board of Trade, the local manufacturers organized a syndicate, called the 'Verein Basler Chemische Fabriken,' under the Swiss Import Trust.

"The quantity of artificial indigo exported to the United States in 1916 declined by 212,521 pounds, but was valued at $150,229 more than that shipped in 1915. That there was an actual increase in value is unlikely, but the new tariff law making this color dutiable compelled the manufacturers to state the market value, whereas formerly, under free entry, they gave only nominal values in their invoices. The decrease in quantity should probably be attributed to the activity of the British firm at Ellesmere Port, which produced a great deal of artificial indigo in 1916.

"The trade in extracts became normal again last year. Long-delayed shipments of China galls were received and utilized in the factories. Both logwood and yellow wood were imported in sufficient quantities to meet the demands of the manufacturers."

Japanese Dyestuff Industry.

The manufacture of coal-tar dyestuffs in Japan has now reached the point at which apparently the domestic demand for certain staple products is fairly well met. The Japanese Government is now issuing permits for the export of sulfur black, aniline salts and certain alizarin colors. It is announced that shortly other products will be added to the list. There is evidently an effort to protect the reputation of the dyes exported from the island kingdom. Samples must be submitted for examination by Government analysis before permits are granted.

Japanese chemists while building up the new national dyestuff industry, contend with numerous handicaps in the matter of supplies and equipment. The "Nippon Dyestuff Manufacturing Co." has issued its third balance sheet, showing a deficit of $15,000. There is, however, an annual subsidy to the company, from the Japanese Government amounting to about $60,000.

British Exports of Dyestuffs and Coal-Tar Products.

During the month of July, 1917, the United Kingdom exported dyestuffs valued at $678,000 as compared with $403,000 in July, 1916. Coal-tar products, not dyes, were valued at $1,699,000, as compared with $1,015,000 for July, 1916.

NATURAL DYES

Preparations for Indigo Fermentation Vats.

Dr. A. Schmidt, of Höchst-on-the-Main, Germany (Amer. Pat. 1,239,526, of Sept. 11, 1917), has devised a class of stable, concentrated preparations for indigo fermentation vats, which may be of material value in connection with dyeing processes involving the use of indigo, as well as useful in the studies, now being carried on in India, to standardize the manufacture of natural indigo. The nature of these preparations is seen from the following statements:

The action of the so-called "cold oriental indigo vats" is due, for the most part, to phenomena of fermentation. They are caused by bacteria which require for their existence and growth nitrogenous nutrient media and consequently it has been found that by adding fermentable but not non-nitrogenous bodies, such as glucose, cane sugar, starch, etc., a cold fermentation vat cannot be satisfactorily started and continuously kept working. In practice there has already for a long time been used as "fermentable materials" as they were called, besides syrup, starch, glucose, etc., also bran, which contains vegetable albumin, i. e., nitrogenous material. It has been attempted to mix stable-indigo and indigo-white pastes with "vat-fermentation agents" with the addition of alkalis in order to convert them thereby into a stable form. Thus, according to a well known process 200 parts of indigo are made into a paste with 100 parts of wheat flour, 50 parts of syrup, 10 parts of quick lime and 540 parts of water. This process shows, however, the disadvantage that the paste thus obtained becomes putrefied and ferments as soon as the alkaline reagent disappears for some reason, for instance in consequence of the lime being consumed by the carbonic acid in the air.

The inventor finds that stable concentrated albumin preparations can be obtained which retain their action in the cold indigo fermentation vat, by mixing isolated albumin substances with water-soluble carbohydrates, for instance with molasses, glucose or the like, or with equivalents of water-soluble carbohydrates of high concentration, for instance glycerin. Thus valuable stable albumin-preparations are obtained either by mixing a concentrated water-soluble carbohydrate, for instance with the moist extract containing a high percentage of albumin (gluten), obtainable by extracting or boiling bran or an albuminous seed with water and, if required, subsequently evaporating; or, for instance, with other albuminous substances (albuminates), such as vegetable casein, casein or the like and also with albumoses, peptonoid products or the like. The high percentage of sugar causes preservation of the albuminous material in spite of its containing water and the sugar itself serves then as one of the fermentation agents in the vat. By such preparations it is possible to start well the so-called cold lime-fermentation vat and to keep it working. The indigo vats prepared with such albuminous and sacchariferous products show a much better condition than those prepared for instance with glucose alone; the deposit of the vat, when agitated, shows a pure yellow color which is not the case with the ordinary glucose-lime vat: the vat has not so great a tendency to deposit, etc., and works in many respects better than the ordinary glucose lime vat owing to the albumin it contains.

In making such concentrated albuminous-carbohydrate preparations there may be added, besides the bacteria contained in the albuminous raw products themselves, other materials containing bacteria, such as finely cut hay, or hay-tea, or portions of a fermentation liquor of lactic acid or butyric acid.

On mixing indigo or indigo white with such preparations, and evaporating to dryness, stable products are obtained, capable of preservation and available for use at any time in starting a cold fermentation vat.

Vegetable Dyes in the Philippines.

In a recent report the Philippine Bureau of Science states that probably more than a hundred species of plants containing valuable color principles are found in the islands, and many more could be readily cultivated. In most cases the colors produced are inferior in quality, being either fugitive or lacking in brilliancy. As the plants that yield dyeing materials grow wild and often are widely scattered, the supply is unreliable and insufficient. Little has been done towards developing the manufacture of local coloring materials, and until there is an intensive cultivation of the necessary plants, and the capital necessary for the enterprise can be secured, there is little prospect of commercial success.

Only two Philippine dye plants are commercially important. These are indigo and sappan or sibucao. Others are used locally, but scarcely enter into domestic commerce, much less into the external commerce of the Archipelago.

Sappan or sibucao is a shrub or small tree, widely distributed in the settled areas of the Philippines at low and medium altitudes. It is not systematically cultivated, but in a few districts, such as Guimaras Islands and parts of Panay, it is found in great abundance. In general, it appears only as a widely scattered tree. The wood is annually exported in considerable quantities to China.

Exports of sappan wood from the Philippines to China and Hong-Kong in 1914 amounted to 2,137,000 pounds, valued at $9,400.

The wood yields, an extraction with water, about 2 per cent of coloring matter, essentially the same as that obtained from the Brazil wood, Pernambuco wood, Lima wood and peach wood of South and Central America. All contain brazilin, $C_{16}H_{14}O_5$, closely related by constitution to haematoxylin. Brazilin is destitute of color but dissolves easily in alkalies, yielding a red solution. This, on exposure to the air, oxidizes to brazilein, $C_{16}H_{12}O_5$, which possesses vivid tinctorial properties. It is used to some extent in cotton dyeing and calico printing and occasionally on wool, chiefly in connection with other dyes. The brighter lakes with aluminum mordants find a limited use. The dye is quickly affected by light and washing. The extraction is not carried on in the Philippines, but in the countries importing the wood.

Indigo, locally known as tayum, tayom, tagum, pouay, tayum-tayum, and tagung-tagung, has been in the past extensively cultivated in some parts of the Philippines, and the prepared product entered extensively into the export trade. With the development of the coal-tar dye industry and the manufacture of artificial indigo, however, the production of indigo as a commercial crop in the islands practically ceased. It is still cultivated on a small scale in some parts of northern Luzon, but only to supply a limited local demand. It is highly probable that the extraction of natural indigo might be profitable at present, but the rehabilitation of the industry would take time and a considerable investment of capital in extraction vats. With the practical certainty that at the close of the war the industry would suffer from the competition of synthetic indigo, there seems to be no inclination to take risks.

Brown dyes are obtained from numerous plants, chiefly from the shrub or small tree known as bancudo or nino (Morinda indica, Linn.) certain of the mangrove trees, such as ceriops and bruguiera, the bark of xylocarpus (tabigue or nigui), and from numerous others less important sources. Bancudo is the well-known al dye of India. Cotton mordanted with tannin is colored dark red with this material.

Black dyes are secured from Herritiera litoralis, a common coastal tree, and from some species of Hibiscus, Semecarpus, Terminalia, and Diospyros. The determining factor in most cases is the presence of tannin in large quantities.

Yellow dyes of minor importance are secured from the seeds of Bixa orellana (annatto; from the wood of nauclea (baucal); from Carthamus tinctorius (safflower) which is occasionally cultivated as a dye plant; from the bark of the common mango; from some species of Vitex (molave); and from ligtang, a woody vine having yellow wood rich in berberine.

Seaweed as a Dyestuff

Public interest in the United States has been centered upon seaweed as a prospective source, on a large scale, of potash salts. In other countries the utilization of the material has been studied with much greater care and minuteness. The Japanese manufacture from seaweed some 27 different commercial products. In Europe, seaweed has been used for various purposes in the textile trade for many years, and several patents have been taken out concerning several departments of the industry in which it has proved to be of assistance. For instance, in 1881, C. V. Stanford patented a process for obtaining algin from seaweed, to be used as a dressing and for finishing textiles, as well as a thickening for coloring matters. In 1902, J. Y. Johnson patented a process, whereby laminaria from seaweeds could be employed as an inert medium for packing and transporting indigo.

In a recent patent, taken out by N. Malcolmson and H. Kelsey, a method is described for directly employing various groups of seaweeds for the production of dyestuffs in the form of paste or powder.

The Melanospern, Rhodospern, and Chlorospern groups contain pigments of various colors. Certain colors are remarkably constant in large natural algæ groups. Thus, the Fucaceæ exhibit a brown or olive color, and the Florideæ a beautiful rose-red. To obtain the coloring matter, the seaweed is boiled until it has become soft, after which it is crushed to form a paste, or the seaweed may be roasted and ground to form a powder. The dye liquid is made up of equal parts of powder or paste and sulfuric acid, say 1 oz. dissolved in 1 gallon water. The colors imparted to the fabrics are fast, and do not necessarily require the use of mordants. The seaweed dyestuff can be used along with other dyestuffs in mordants, liquors, or topping baths, to give a variety of shades.

The seaweed can also be used raw, that is, put into the bath along with the fabric to be dyed and boiled with it, using 1 oz. of seaweed per lb. of fabric. This process, however, requires much boiling, and is not as satisfactory as when the seaweed has been previously prepared.

The Dyeing of Chinese Rugs.

American lovers of oriental rugs are becoming increasingly familiar with the products of Chinese looms. The methods of dyeing the yarn used in these rugs are exceedingly primitive, but the colors obtained are exceptionally fast. The following account of the materials employed and the method of application recently appeared in "The Dyer and Calico Printer," and is of general interest:

The wool that enters into Chinese carpets is grown in Mongolia, and the yarn is spun by old men and idle women in the border villages. Each spinner strolls about with a wad of raw wool and a hand spindle, and accumulates a ball of yarn by a mechanical twirling of the spindle while entering vigorously into the gossip of the day. As no shuttle is used in the weaving of the carpets, so there is no wheel used in the spinning of the yarn. The Chinese rug is most literally hand-made.

The Ninghsia dyes never fade, but gain in lustre as they age. A twenty-four-year-old carpet, far from being worn out, has a silky brilliance and gloss which cannot be imitated. The native dyes used in Peking, when properly set, will outlast the carpet, and nothing has yet been discovered in China which will bleach the rug without ruining the carpet, if the dyer has done his work conscientiously. Actual experiment has shown that it is possible to boil a new rug to shreds without extracting the dye out of the yarn.

Each rug maker does his own dyeing to match the colors in the design submitted to him. At one dyeing he makes enough to finish the carpets, so that there can be no possible variation in shade, and he has his whole supply of the various colors dyed, set and dried, ready for the client's inspection before he sets his men to work on the loom. Minerals are rarely used. Their blue is indigo; the locust tree, which also yields black; brown comes from a kind of acorn husk; purple from hollyhocks: and yellows, reds, greens and other shades from various native woods, mostly cheap and abundant.

The dyer takes as much dyewood or seed as his judgment prompts him to use, throws it into a great pot of boiling water, and when the liquid takes on color throws in the yarn, and sets a man to stir it. The fixing of the colors is done with alum. A rug made partly with yarn dyed with the native vegetable dyes and partly with aniline dyes fades in streaks and patches, and betrays itself in a few months, but the colors in a well-dyed Peking rug temper evenly and bear any amount of washing. Strong soap and water have no more effect on a good rug than they have upon a good handkerchief, and often make a surprising difference in the ornamental qualities of a carpet that appears hopelessly old and dirty.

The recent carpet boom has made the Chinese carpet an article of trade, and has given it the status of a useful and ornamental floor covering. The successful buyers in the carpet centres have worked hard to impress their ideas upon the native artists, with the result that the Chinese are developing a perception of color and arrangement as the foreigner sees them, and are relegating their old patterns to the dust-bins.

Chinese Indigo.

A consular report states, that the cultivation of indigo has been notably augmented in the Swatow district, China. The export of crude indigo, in a paste form, increased from 1,683 short tons in 1913 to 5,388 tons in 1916. The dyestuff is sent chiefly to other parts of China, and also to Siam and Singapore. The methods of extraction employed are much cruder than those used in India.

Dyestuffs Used in Japan.

A leading Japanese merchant, now in New York, states that about one half of the dyes, now currently employed in Japan, come from American manufacturers. The remaining half are of domestic make. The latter fail, thus far, to approach the American standards of strength and purity.

SYNTHETIC DRUGS AND PERFUMES PHOTOGRAPHIC DEVELOPERS

The Role of Saccharin During the War.

In company with a few other coal-tar compounds, such as phenol, picric acid and trinitrotoluene, saccharin has come to occupy a position in the forefront of the chemical stage during the world war. The *Oil, Paint and Drug Reporter,* in its issue of Sept. 24, furnishes an exceedingly interesting portrayal of the record established by this product,—one of the very few industrial coal-tar compounds originating in the United States:

"The exigencies of the present war have been responsible for the rise to prominence of many items which prior to the new demands incident to changes in consumption were at most little more than torpid. The chemical and drug markets include many commodities which have seen violent fluctuations in price, because of increased demand and decreased output, but there have been few which have established such a record as saccharin.

"During the period of general world normality prior to the first movement in the direction of a general world conflagration, saccharin, while in steady demand for certain medical and technical uses, did not, save in some isolated cases, enter into general consumption. It is true that in several European countries there was a limited demand for this product of the laboratory as a substitute for beet or cane sugar, but such use was forbidden in the United States.

"With the carrier shortage incident to the establishment of embargo lines and neutral zones, the unavailability of shipping to transport sugar to the Continent, the labor scarcity and the need for the tillable land for foodstuffs on the Continent—all of which meant extremely high prices for cane and beet sugar because of high freights, insurance, etc., when the sugar could be obtained—the consumption of saacharin increased enormously. Even in Germany, where the beet sugar output has been enormous in the past, the change to this coal-tar derivative has been made to a considerable extent: and in Russia, Sweden and Norway such a demand has been created that special trips to the United States have been made by individuals, who have bought saccharin here in the open market, paid the necessary duty and taken the chemical sweetner back with them for sale at a notable profit.

"The result of this changed consumption has been a remarkable increase in the prices paid in the markets of this country. It is estimated that of the total amount sold in American markets during the past six months 75 per cent. at least has been for foreign consumption. The fact that saccharin is approximately 500 times sweeter than sugar makes it possible to ship by parcels post and in small packages an amount which, while not large in bulk, equals a sugar tonnage that it would be impossible to transport, with resulting tremendous saving in the item of freight alone.

"An idea of the demand for saccharin can be gained from the following comparison of price quotations in the New York market, from July, 1914, to date, the figures showing the high and low for the year. with the exception of the first price, which was for the month prior to the declaration of hostilities:

Year.	Range.
1914 (July)	$1.15@$1.25
1915	2.85@11.50
1916	11.50@21.50
1917	20.50@46.00

"The demand for saccharin in this market has been largely for immediate shipment, and while producers are making every effort to meet the demands, it has been found difficult to supply the requirements at short notice, and as a result the market has been in the hands of speculative interests to an unusual degree. The contract price today is nominally approximately $26 a pound, whereas for immediate shipment to Europe as high as $46 has been paid for the insoluble variety within the past week."

Enlargement of the Monsanto Works.

The Monsanto Chemical Co., of St. Louis, has been one of the leading factors in establishing in our country the manufacture of synthetic coal-tar medicinals. Its work in this field has extended so rapidly that the company now finds it necessary to enlarge its plant on a large scale. Plans have been completed for the erection and equipment of additional buildings on the Illinois bank of the Mississippi, opposite St. Louis, which involve an outlay of $1,500,000. The company hopes, in its enlarged quarters, to be able to so expand its production of various synthetic drugs that the United States can be permanently freed from dependence upon the European sources from which they have hitherto been chiefly obtained.

Army Supplies.

The Field Medical Supply Depot of the American Army is laying in extensive quantities of drugs for the forthcoming campaign. In its latest call for bids, among several hundred items, were nearly

5 tons of phenol in ½-lb. bottles, 7,500 bottles of acetyl-salicylic acid, each bottle containing 500 tablets, 5,250 bottles of salicylic acid and 15,500 bottles of sodium salicylate.

MISCELLANEOUS

The Federal Dyestuff and Chemical Corporation.

Receivers have been appointed by the Federal District Court to take over the affairs of the Federal Dyestuff and Chemical Corporation. This company was organized in 1915 with an exceptional amount of capital and plans were made for a varied and extensive range of manufacture, covering a large number of coal-tar colors and the chemicals required in their production. During 1916 very large blocks of stock were offered for sale, and the transactions assumed dimensions unusual in connection with companies engaged in the manufacture of colors.

The company has a floating debt of about $400,000 and $2,000,000 of first mortgage 6% gold notes are due June, 1918.

The plant at Kingsport, Tenn., including buildings, land and equipment, is valued by the management at $4,000,000. In addition stock on hand, including raw materials, finished product and semi-finished product is valued at $800,000 to $900,000. Last year the corporation did a business of approximately $2,000,000 of which $400,000 to $500,000 represented profits. It is stated by the management that this profit, under the arrangement by which the company was financed, was not at present available for interest or dividends.

The plant is equipped to manufacture a large variety of colors, but its full possibilities have not yet been utilized. Production is confined to a few dyes, chiefly sulfur colors, and some staple chemicals.

The receivership is a friendly one and the officers of the corporation feel that there is no reason to fear the outcome if the company is permitted to keep going.

Current Literature.

Color chemists will find matters of interest in the following articles, which have recently appeared:

"The Theory of Color Lakes," J. O. Baudisch, Z. Angew. Chem., 1917, 30, 133; abstracted in J. S. C. I., 1917, 36, 705.

"The Chemistry of the Sulfide Dyestuffs," F. M. Rowe, J. Soc. Dyers, 1917, 33, page 9.

"Using the Photoelectric Cell as a Photometer," J. R. Randolph, Elect. World, 1917, 69, 1166.

"Studies of the Ultra Violet Transparency of Certain Colored Media," H. W. L. Absolom, Phil. Mag. & J. Sci., 1917, 33, 450.

"Paper Yarn Textiles and Dyeing and Impregnating Them," A. Kertesz, Sci. Amer. Suppl., 1917, 84, No. 2167, page 19.

"The Testing of British Army Cloths," Howard Priestman, Text. World J., 1917, 53, 25.

"Studies of the Amines; the Employment of the Hypochlorite Color Reaction to Establish the Mechanism of the Reaction of Sulfate of Methyl on Aniline," N. A. Shepard, J. A. C. S., 1916, 38, 2507.

"Determination of the Nitrotoluenes," E. Knecht, J. S. C. I., 1917, 36, 694.

Qualitative Spectrum Analysis of Organic Dyestuffs by Formanek's Method.

A careful review of the objections of Muller, Lefevre, Andre, Eijdman and Weigart, and discussion of the difficulties encountered in the use of qualitive spectrum analysis of dyestuffs by Formanek's method is given by J. Pokorny in the Journal of the Society of Dyers and Colorists of recent date. The two greatest objections, namely the optical errors, caused by contrast action and the displacement of bands in mixtures, are shown to be without just foundation. Mr. Pokorny highly recommends the spectroscopic method for the identification of dyestuffs as the result of long experience and especially because such simple apparatus is suitable. Chemical methods on rare occasions were employed to assist in identification.

(J. Pokorny, J. Soc. Dyers and Colorists, 1917, 33, 162.)

Intra-vitam Color Reactions.

N. A. Cobb, of the U. S. Department of Agriculture, is reported in Science (1917, 46, No. 1181) to have stated that if substances giving color reactions in living tissues could be applied to small transparent, varied and highly complex living organisms under circumstances that would permit microscopic examination while the reactions are in progress, it seems certain that important advances would be made in our knowledge of nutrition, growth and decay. Such conditions are realized by feeding coal-tar dyes to free living nematodes which constitute a group of hundreds of thousands of species and an inconceivable number of kinds of physiological action.

By using special precautions as to the kind of glasses in the microscope, in the preparation of the slide and the quality of the light for illumination and by using a great variety of coal-tar compounds, the author demonstrated the existence of an unsuspected number of kinds of "granules," functioning in different roles within the living cell.

Decolorizing Carbon.

The secrets of the decolorizing action and of the preparation of the Eponite and Norite, the two marvelously efficient carbon blacks made in Germany and the Netherlands, respectively (Nederlandsche Noritmaatschappij, Declora, Amsterdam), have been unraveled. After many experiments using different woods, pine, cedar, poplar, willow, treated or untreated with lime, magnesia, salts, starch, mucilage, at low and high temperatures, and water under all conceivable conditions, the results found were that charcoals from natural wood, without treatment, were useless as decolorizing agents, but woods treated with milk of lime or calcium acetate, carbonized at a white heat, gave charcoals more effective than eponite. Any porus wood gave an active charcoal.

The process used is as follows: Mix pine, willow or cedar sawdust with milk of lime to form a dough; heat to drive off some water and while still damp place in a crucible; cover with a layer of lime and raise nearly to a white heat. Cool, add water containing an excess of hydrochloric acid, boil, filter, wash with hot water, drain and heat in an iron retort to red heat. Finally powder to charcoal and sift through a 60-mesh sieve.

(Experiments of Royal Soc., Chem. Tr. J., 1917 61, 218, No. 1582.)

Utilization of By-Products.

An interesting discovery has been made and patented by a German chemist, Willy Moeller. The residual products produced in oil refineries by treatment of crude mineral oil with concentrated sulfuric acid, known as acid resins, constitute a troublesome waste. The patentee has found that these products contain substances—probably condensed sulfonated hydrocarbons, which possess in high degree the property of forming leather, that is, the acid resins after removal of the sulfuric acid constitute a very good tanning agent.

The acid mass is diluted with water and neutralized with an alkali, alkaline earth or their carbonates. The sulfate having been removed by crystallization or clarification, the liquor may be concentrated for market or diluted for direct use. The hides are prepared as for the usual tanning process and conversion of hide into leather can be made by the old pit process or in the tanning vat. The leather obtained has great elasticity and resembles chrome leather in its chemical properties.

(Willy Moeller, Ger. Pat., The Leather Mfr., 1917, 28, 247, No. 10.)

New Book on Color.

The latest work of J. W. Lovibond on "Light and Colour Theories and Their Relation to Colour Standardization" is concerned with those methods of analyzing, measuring and recording the colors of objects which have proved of practical value in industrial applications. The method of color matching by glass units in three primary colors, red, yellow and blue, is now a familiar one in trade, and has proved of limited but unquestioned value. The chapters in the new work take up various color theories, the evolution of the authors' method, the kind of light best adapted for color matching, the use of the term "specific color development," which is analogous to specific heat or specific gravity, and a method of tabulating all colors in three dimensions.

Fire in a Salicylic Acid Plant.

The large plant of the British-American Chemical Co., at College Point, L. I., was destroyed by fire on Oct. 13, the loss being estimated at $250,000. This factory was erected in 1916 by a competent London engineer, and has been an important factor in contributing to the domestic output of salicylic acid.

The fire had its origin in an explosion in one of the condensing systems, and there is no suspicion that it was due to any deliberate attempt on the part of those working in the interests of our enemies, as has been the supposed case in some of the conflagrations at works in the coal-tar chemical industry.

The Photometry of Luminescent Substances.

The measurement of the brightness of fluorescent and phosphorescent substances presents a large and valuable field for study since the present activity in night operations in war has caused a very great demand for self-luminous compounds. Arthur Blok discusses various photometric methods, the difficulties encountered, and other points of interest and concludes that those who are conversant with the better-known applications of photometry might well devote attention to the luminous phenomena shown by this class of substances.

(Arthur Blok, Sci. Amer. Suppl., 1917, June 9, No. 2162.)

The Century Colors Co.

A new organization, termed the Century Colors Co., replaces the Cassella Color Co., of Philadelphia, taking over the entire technical and sales staff of the latter company.

August Exports of Coal Tar Colors.

The exports of artificial dyes from the United States during the month of August were valued at $196,000, as compared with $497,000 during the preceding month.

Among the subscriptions to the second issue of the Liberty bonds was one of $500,000 from the National Aniline and Chemical Co.

Fire Destroys N. J. Chemical Works.

With a loss estimated at about $50,000, fire recently destroyed the plant of the Transatlantic Chemical Company, Linden, N. J.

To Manufacture Paints and Varnishes.

To manufacture paints, varnishes, etc., Slavin and Sipkin, Inc., Newark, N. J., have been incorporated with a capital of $10,000 by R. and I. Slavin and A. Sipkin, Newark.

New Chemical Firm.

Chemicals and kindred products will be manufactured by Webster & Company, recently incorporated at Philadelphia, Pa. The capital of the new firm is $50,000 and the incorporators are M. Mills, John Kearns and C. A. Murphy, Philadelphia.

Penman-Littlehales Improvements.

The Penman-Littlehales Chemical Company, Syracuse, N. Y., is preparing for the erection of additions and improvements to its works to the value of $25,000.

Chemicals and Minerals.

With a capital of $100,000, Miner-Edgar Co., Newark, has been incorporated to deal in chemicals and minerals. The incorporators are Henry M. Miner, James C. Thornton and N. M. Goodlet, Jr.

To Manufacture Lime and Potash.

The American Lime and Potash Products Corporation has been incorporated at Roanoke, Va., to manufacture lime, potash and their by-products. The incorporators are F. M. Hughson, Roanoke, and E. S. Hamilton, W. Va.

CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS

CRUDES.

Anthracene, 80 p. c.	lb.	.22	.26
Benzol, pure, water white	gal.	.47	.50
Benzol, 90 p. c.	gal.	.46	.48
Cresol, U. S. P.	lb.	.18	.20
o-Cresol	lb.	.30	.35
Cresylic acid, 95-97 p.c.	gal.	1.10	1.15
Naphthalene, Flake	lb.	.09½	.09¾
Balls	lb.	.10	.10½
Phenol (carbolic acid), U.S.P., cryst., drs.	lb.	.53	.54
Pitch, various grades	ton	8.00	20.00
Solvent naphtha, water white	gal.	.18	.25
Solvent naphtha, crude, heavy	gal.	.13	.16
Toluol, pure, water white	gal.	2.00	2.10
Toluol, commercial, 90 p.c.	gal.	1.85	1.90
Xylene, pure	gal.	1.00	1.25
Xylene, commercial	gal.	.35	.40

INTERMEDIATES AND EXPLOSIVES.

Amido - naphthol - disulfonic acid (H-acid; 1.8.3.6)	lb.	3.00	3.25
Amido-naphthol-sulfonic acid	lb.	—	1.75
p-Amido-phenol	lb.	4.50	5.00
p-Amido-phenol hydrochloride	lb.	5.00	5.25
Amino-azo-benzene	lb.	1.75	1.85
Aniline oil	lb.	.26½	.27½
Aniline salts	lb.	.33	.34
Aniline for red	lb.	1.12	1.15
Benzaldehyde	lb.	5.00	5.50
Benzidine	lb.	1.85	1.90
Benzidine sulfate	lb.	1.45	1.50
Benzoic acid	lb.	5.50	8.00
Crude	lb.	3.00	3.50
Benzylchloride	lb	1.50	1.75
Chloro-benzene	lb.	.22	.23
Diamido-phenol	lb.	9.00	10.00
Dichloro-benzene	lb.	.35	.40
o-Dichloro-benzene	lb.	.15	.16
p Dichloro-benzene	lb.	.40	.42
Diethyl-aniline	lb.	3.75	4.25
Dimethyl aniline	lb.	.58	.60
Dinitro-benzene	lb.	.33	.35
m-Dinitro-benzene	lb.	.45	.50
Dinitrochloro-benzene	lb.	.40	.42
Dinitro-naphthalene	lb	.44	.75
Dinitro-phenol	lb	.56	.60
Dinitro toluene	lb	.55	.60
Diphenylamine	lb.	1.00	1.10
Ethyl-aniline	lb.	1.00	1.25
Hydroquinone	lb.	2.00	2.10
Hydrazobenzene	lb.	1.50	2.00
Naphthionic acid, white	lb	1.80	1.85
a Naphthol	lb.	1.50	—
b Naphthol	lb	.65	.70
Sublimed	lb.	.87	.90
a Naphthylamine	lb.	.70	.80
b-Naphthylamine	lb.	1.75	2.00
Sublimed	lb	2.50	3.00
p-Nitraniline	lb	1.25	1.35
Nitrobenzene	lb.	.20	.22
Oil of Mirbane, ref	lb	18	20
o Nitrochloro benzene	lb	50	.56
Nitro naphthalene	lb	.44	.65
Nitrotoluene	l	.55	.65
o Nitrotoluene	lb	.80	.90
p Nitrotoluene	lb	1.50	1.60
m Phenylene diamine	lb	1.15	1.25
p Phenylene-diamine	lb	3.50	4.50
Phthalic anhydride	lb	6.40	6.50
Picric acid, kegs	lb.	.85	1.00
Resorcinol, cryst., U. S. P.	lb.	16.00	17.00
Technical	lb.	8.50	9.00
Salicylic acid, U. S. P.	lb.	.80	1.40
Sulfanilic acid	lb.	.32	.34
Tetra-nitro-methyl-aniline	lb.	—	2.50
Tolidine	lb.	2.75	3.00
Toluidine	lb.	1.00	1.10
o-Toluidine	lb.	.80	.90
p-Toluidine	lb.	2.00	2.25
m-Toluylene-diamine	lb.	1.70	1.75
Xylidine	lb.	.75	.80

SYNTHETIC MEDICINALS, FLAVORS AND PERFUMES.

Acetanilide, C. P., bbls.	lb.	.65	.68
Acetphenetidine	lb.	8.50	9.50
Acetyl-salicylic acid, bulk	lb.	3.00	3.50
Antipyrine, bulk	lb.	22.00	23.00
Bismuth salicylate	lb.	3.15	3.20
Calcium sulfocarbolate	lb.	1.40	1.45
Ethyl benzoate	lb.	—	6.50
Phenacetin (Bayer)	oz.	—	2.40
Phenolphthalein	lb.	9.50	10.50
Potassium salicylate	lb.	2.90	2.95
Saccharin	lb.	41.00	46.00
Salol	lb.	1.50	1.75
Sodium benzoate, granulated, U. S. P.	lb.	2.20	2.30
Sodium salicylate, U. S. P.	lb.	1.32	1.35
Wintergreen oil, Synthetic, U. S. P.	lb.	.75	.85
Zinz salicylate	lb.	—	3.25

PHOTOGRAPHIC DEVELOPERS.

Adurol, 16-oz. bottles	ea.	—	10.00
Agfa (intensifier), 2-oz. bottle		—	.40
Amidol, 1-oz. bottle	oz.	.65	.75
Dianol, 1-oz. bottle	oz.	—	.80
Eikonogen	oz.	—	.45
Glycin, 1-oz. bottle	oz.	—	.80
Hydroquinone	lb.	2.00	2.10
Monomethyl-p-amido-phenol (identical with metol)	oz.	—	3.50
Nero (identical with amidol), 1 oz.	oz.	—	.30
Optol, 1-oz. bottle	oz.	—	.80
Pyrogallic acid, crystals	lb.	2.95	3.15
Rodinal, 3-oz. bottle	ea.	—	.75

ARTIFICIAL COLORS.

Acid Black	lb.	1.50	1.80
Acid Blue	lb.	2.40	2.90
Acid Brown	lb.	2.75	3.35
Acid Fuchsine	lb.	8.50	9.00
Acid Green	lb.	3.50	12.00
Acid Orange	lb.	.80	1.10
Acid Orange II	lb.	.65	1.00
Acid Orange III	lb.	1.50	2.00
Acid Red	lb.	1.50	2.00
Acid Scarlet	lb.	4.00	4.50
Acid Yellow	lb.	1.50	2.50
Alizarin Blue	lb.	6.50	7.00
Alizarin Blue, bright	lb.	8.50	9.50
Alizarin Blue, medium	lb.	6.00	7.50
Alizarin Orange	lb.	6.00	8.50
Alpine Red	lb.	7.25	8.00
Alpine Yellow	lb.	6.50	7.50
Auramine	lb.	4.00	5.00
Aurine	lb.	2.60	3.00
Azo Carmine	lb.	6.00	6.50
Azo Yellow	lb.	3.00	5.00
Azo Yellow, red shade	lb.	3.00	5.00
Bismarck Brown Y	lb	1.10	1.40
Bismarck Brown FF conc.	lb.	2.00	2.50
Bismarck Brown 3 R	lb.	2.25	3.25
Bismarck Brown R	lb.	1.50	2.00
Bright Red	lb.	2.75	3.25
Chrysamine Yellow	lb.	2.00	3.00
Chrysoidine	lb.	2.00	2.50
Chrysoidioe R	lb.	2.25	3.00
Chrysoidine Y	lb.	1.80	2.10
Congo Red	lb.	3.50	4.50
Crystal Violet	lb.	7.50	8.00
Direct Acid Orange	lb.	1.50	2.00
Direct Black	lb.	.80	1.25
Direct Blue	lb.	2.15	3.75
Direct Sky Blue	lb.	6.50	7.00
Direct Brown	lb.	2.75	3.00
Direct Bordeaux	lb.	3.50	4.00
Direct Fast Red	lb.	3.25	4.00
Direct Red	lb.	2.10	2.60
Direct Yellow	lb.	2.00	3.50
Direct Fast Yellow	lb.	3.00	4.00
Direct Violet	lb.	4.25	4.50
Eosin	lb.	10.00	15.00
Fast Red, 6B extra	lb.	4.50	5.00
T extra	lb.	2.00	3.75
Fast Scarlet	lb.	2.75	3.25
Fuchsine	lb.	7.50	12.00
Fur Black, extra	lb.	2.50	3.00
Fur Brown B	lb.	2.00	3.00
Fur Brown GG	lb.	2.50	4.00
Green Crystals	lb.	12.00	14.00
Indigo 20 p.c. paste	lb.	1.60	2.00
Indigotin	lb.	2.50	3.50
Induline	lb.	1.90	2.50
Magenta	lb.	6.00	8.00
Malachite Green	lb.	8.50	12.00
Metanil Yellow	lb.	2.50	3.00
Medium Green	lb.	5.00	6.00
Methylene Blue, tech.	lb.	3.00	4.00
Methyl Violet	lb.	3.50	4.00
Naphthol Green	lb.	3.00	3.50
Nigrosine, oil sol.	lb.	1.00	1.50
Nigrosine, sp. sol.	lb.	.90	1.50
Nigrosine water sol., blue	lb.	80	1.10
Jet	lb.	.85	1.50
Naphthylamine Red	lb.	6.50	7.00
Oil Black	lb.	1.00	1.75
Oil Green	lb.	2.00	3.00
Oil Orange	lb.	2.00	2.50
Oil Scarlet	lb.	2.00	2.50
Oil Yellow	lb.	1.80	2.50
Orange RG	lb.	2.00	2.25
Orange Y, conc.	lb.	1.10	1.50
Ponceau	lb.	1.75	2.50
Quinoline Yellow	lb.	5.00	11.00
Rhodamine	lb.	5.00	6.00
Safranine	lb.	7.00	8.00
Scarlet 2 R	lb.	5.50	6.00
Soluble Blue	lb.	18.00	25.00
Sulfur Black	lb.	.75	1.00
Sulfur Black, 150 p.c.	lb.	1.50	2.25
Sulfur Blue	lb.	2.60	3.25
Sulfur Blue Black	lb.	2.00	3.00
Sulfur Brown	lb.	.50	.60
Sulfur Green	lb.	2.00	3.00
Sulfur Yellow	lb.	2.00	2.50
Tartrazine	lb.	1.50	2.00
Wool Orange	lb.	3.00	4.00
Victoria Blue	lb.	15.00	22.00
Victoria Blue, base	lb.	15.00	17.00
Victoria Green	lb.	14.00	17.00
Victoria Red	lb.	8.00	9.00
Victoria Yellow	lb.	7.50	8.75
Yellow for wool	lb.	1.60	2.25

NATURAL DYESTUFFS.

Annatto, fine	lb.	.33 — .34
Seed	lb.	.11 — .14½
Carmine No. 40	lb.	4.25 — 4.75
Cochineal, Teneriffe, Silver	lb.	.54 — .55
Gray	lb.	.54 — .55
Indio, Bengal	lb.	3.25 — 3.50
Oudes	lb.	3.00 — 3.25
Guatemala	lb.	2.75 — 3.00
Kurpabs	lb.	2.75 — 3.15
Madras	lb.	1.15 — 1.30
Madder, Dutch	lb.	.27 — .29
Nutgalls, blue Aleppo	lb.	— — —
Chinese	lb.	.25 — .26
Persian Berries	lb.	— — —
Turmeric, Madras	lb.	.08¾— .09½
Aleppey	lb.	.10 — .10½
China	lb.	.08 — .08½

DYEWOODS AND RAW MATERIALS.

Algarobilla	ton	140.00 —150.00
Barwood	lb.	.06 — .08
Camwood, chips	lb.	.17 — .20
Divi-Divi	ton	65.00 —70.00
Fustic, sticks	ton	50.00 —53.00
Chips	lb.	.04½— .05
Hypernic chips	lb.	.09 — .10
Logwood, sticks	ton	38.00 —43.00
Chips	lb.	.03 — .03¼
Myrobolans	ton	60.00 —65.00
Quercitron Bark No. 1	ton	28.00 —31.00
No. 2	ton	20.00 —25.00
Red Saunders, chips	lb.	.15 — .17
Sumac, Sicily, 29 p.c. tannin	ton	87.00 —90.00
Virginia, 25 p.c. tannin	ton	50.00 —59.00

EXTRACTS.

Archil, double	lb.	.15 — .17
Triple	lb.	.18 — .20
Concentrated	lb.	.21 — .26
Chestnut, 25 p.c. tannin	lb.	.02¼— .02¾
Clarified, 25 p.c. tannin	lb.	.02½— .03
Cutch, Rangoon, boxes	lb.	.12 — .13
Liquid	lb.	.08½— .09
Tablet	lb.	.10 — .12
Cudbear, French	lb.	.70 — .80
English	lb.	.18 — .24
Concentrated	lb.	.75 — .85
Flavine	lb.	1.00— 1.50
Fustic	lb.	.13 — .16
Gall	lb.	.20 — .21
Gambier, 25 p.c. tannin	lb.	.10 — .10½
Common	lb.	.16 — .16½
Cubes, No. 1	lb.	.22½— .23
No. 2	lb.	.21 — .21½
Hematine	lb.	.09 — .10
Crystals	lb.	.20 — .28
Hypernic, liquid	lb.	— — —
Indigo, natural, for cotton	lb.	.50 — .54
For wool	lb.	.30 — .32
Indigotin, 100 p.c. pure	lb.	— — 5.50
Logwood, solid	lb.	.19 — .21
Crystals	lb.	.19 — .24
51° Tw.	lb.	.09½— .12
Myrabolans, 25 p.c. tannin	lb.	.06 — .07
Solid, 50 p.c. tannin	lb.	.10 — .11
Osage Orange—		
Powdered, Aurantine	lb.	— — .25
Paste	lb.	.06 — .12
Persian Berries	lb.	.20 — .25
Quercitron	lb.	.07¼— .08¼
Sumac, liquid, 25 p.c. tan	lb.	.06 — .10½

DYEING ACCESSORIES.

Acetic acid, 28 p.c	lb.	.05½— .07
56 p.c.	lb.	.11 — .12½
Glacial, 99 p.c	lb.	.35 — .45
Albumen, Egg	lb.	1.05 — 1.10
Blood, imported	lb.	.58 — .61
Domestic	lb.	.53 — .54
Alum, ammonium, lump	lb.	.04 — .04½
Alum, chrome	lb.	.25 — .28
Alum, potassium, lump	lb.	.08½— .09
Aluminum acetate	lb.	.80 — .90
Aluminum chloride, liq	lb.	.04½— .05
Aluminum sulfate, techn	lb.	.02 — .02¼
Aluminum sulfate, iron free	lb.	.03¼— .03½
Ammonium vanadate	lb.	7.00 — —
Bleaching powder, 35 p.c	lb.	.01½— .02
Borax, cryst.	lb.	.07¼— .07½
Citric acid, crystals	lb.	.72 — .72½
Powdered	lb.	.72½— .73
Copper subacetate(verdigris)	lb.	.40 — .42
Copper sulfate (blue vitriol) 99 p.c.	lb.	.09¾— .10
Dextrine, corn	100 lbs.	— — 7.00
Dextrine, domestic potato	lb.	.14½— —
Ferric sulfate, basic (nitrate of iron), comm	lb.	.01¾— .02¼
True	lb.	.07½— .08
Ferrous sulfate(copperas)	100 lbs.	1.00 — 1.50
Formic acid, 75 p.c	lb.	.40 — .45
Glauber's salt (sodium sulfate)	100 lbs.	1.20 — 1.35
Glycerin, C. P	lb.	.69 — .70
Gum arabic, firsts	lb.	.52 — .55
Seconds	lb.	.48 — .50
Sorts, amber	lb.	.34 — .35
White	lb.	.46 — .50
Gum tragacanth, Alep., firsts	lb.	2.30 — 2.50
Seconds	lb.	1.95 — 2.00
Thirds	lb.	1.65 — 1.85
Sorts	lb.	.75 — .90
Hydrochloric acid (muriatic) 18°	lb.	.01½— .02
20°	lb.	.01¾— .03
22°	lb.	.02¼— .03
Lactic acid, 22°	lb.	.05½— .06¼
44°	lb.	.15 — .16
Nitric acid, 36°	lb.	.07¼— .07½
38°	lb.	.06¾— .07¼
40°	lb.	.08 — .09
42°	lb.	.09½— .10½
Oxalic acid	lb.	.43 — .46
Potassium antimony tartrate (tartar emetic)	lb.	.59 — .60
U. S. P.	lb.	.62 — .67
Potassium bichromate	lb.	.45 — .46
Potassium ferricyanide (red prussiate)	lb.	2.90 — 3.25
Potassium ferrocyanide (yellow prussiate)	lb.	1.27 — 1.35
Potassium tartarate, acid (cream of tartar)	lb.	.52 — .55
Prussian blue	lb.	.80 — .90
Soluble	lb.	.95 — 1.00
Sago flour	lb.	.04¾— .05
Soda ash, 58 p.c.	100 lbs.	3.15 — 3.30
Soda, caustic, 76-78 p.c.	100 lbs.	8.10 — 8.30
Sodium acetate	lb.	.11½— .13½
Sodium bichromate	lb.	.19 — .21
Sodium bisulfite	lb.	.05¾— .06
Sodium chlorate	lb.	.23 — .24½
Sodium ferrocyanide (yellow prussiate)	lb.	.35 — .36
Sodium nitrite techn	lb.	.35 — .37
Sodium phosphate, com	lb.	.04½— .07
Sodium silicate, liquor 50 p.c.,	100 lbs.	1.10 — 1.25
Crystals	lb.	.03¾— —
Sodium sulfide, 60 p.c., fused	lb.	.03 — .03¼
Crystals, 30 p.c.	lb.	.02 — .02¼
Sodium thiosulfate (hyposulfite)	100 lbs.	1.60— 1.75
Soluble oil, 50 p.c.	lb.	.10 — .12
75-85 p.c.	lb.	18 — .20
Stannous chloride (tin crystals)	lb.	.41 — .41½
Stannic chloride (tin bichloride), 50°	lb.	.20¼— .21¼
Starch, corn, pearl	100 lbs.	6.30 — 6.48
Potato	lb.	.12½— .13
Rice	lb.	.08 — .10
Wheat	lb.	.05 — .06
Sulfuric acid, 60°	ton	25.00 —26.00
66°	ton	34.00 —35.00
Oleum, 20 p.c.	lb.	.02 — .02¼
Tartaric acid, crystals	lb.	.78½— .81
Turkey Red oil	lb.	.14 — .16
Zinc dust, 350 mesh	lb.	.18 — .25

IMPORTS AND EXPORTS OF COAL-TAR PRODUCTS AND NATURAL DYESTUFFS

The following is the Government report of imports and exports of these wares for the eight months ending August, 1915, 1916, and 1917, and for the month of August, 1916, and 1917.

IMPORTS

ARTICLES	AUGUST				EIGHT MONTHS ENDING AUGUST					
	1916		1917		1915		1916		1917	
Coal-Tar Products—										
Acid, carbolic ...lbs.	114,953	$8,397	132,704	$9,709	1,615,314	$91.852	1,583,359	$109,587	447,769	$36,063
Alizarin and alizarin dyes ...lbs.	24	6	2,240	10,545	3,120,925	823,312	42,393	66,598	10,187	28,765
Aniline salts ...lbs.	......	......	......	......	248,652	62,410	20	4	......	......
Colors or dyes	......	175,425	......	375,180	......	2,774,225	......	3,071,213	......	1,825,434
Imported from—										
Germany	......	......	......	3,048	......	2,228,960	......	135,589	......	4,497
Switzerland	......	141,604	......	321,287	......	391,331	......	914.808	......	1,411,145
United Kingdom	......	26,454	......	45,512	......	71,572	......	257,126	......	337,382
Other countries	......	7,367	......	5,333	......	82,362	......	1.763,690	......	72,410
Dead or creosote oil ...gal.	2,765.121	152,231	486,174	40,280	21,861,283	1,632.901	34,029,837	2,592,144	8,642,650	687,608
Indigo, natural and synthetic ...lbs.	145,959	202,055	......	......	4,745,766	1,689,402	3,437,431	5,848,928	......	......
Natural ...lbs.	......	......	137,254	246,023	......	......	......	......	1,404,905	2,742.512
Synthetic ...lbs.	......	......	198,580	114,591	......	......	......	......	1,093,890	682,707
Tar and pitch of coal ...bbls.	2,486	5,021	554	816	......	......	17,938	27,980	6,022	9,729
All other coal-tar products ... { free	......	52,579	......	37,354	......	221,850	......	549,481	......	374,403
{ dut.	......	109,601	......	7,712	......	309,573	......	527,698	......	164,758
Total coal-tar products	......	705,315	......	842,210	......	7,605,525	......	12,793,633	......	6,551,979
Dyewoods, in a crude state—										
Logwood ...long tons	22,358	848.900	5,547	134.376	30,021	423,377	155,243	5,027,278	42,937	1,196,656
All other ...long tons	736	17,757	1.885	45,405	14.171	207,058	13,675	301,787	7,401	167,832
Gambier or Terra Japonica ...lbs.	905,967	81,948	1,703,477	196,933	7,229,276	306,970	10,495,947	831,590	8,562,829	815.859

EXPORTS

ARTICLES	AUGUST				EIGHT MONTHS ENDING AUGUST					
	1916		1917		1915		1916		1917	
Carbolic acid ...lbs.	......	......	852.765	$459,186	......	......	......	......	[1]2,243,288	[1]1,185,345
Picric acid ...lbs.	......	......	2,926,143	1,859,719	......	......	......	......	[1]5,643,506	[1]3,802,915
Coal-tar distillates—										
Benzol ...lbs.	......	......	1,669,664	159,956	......	......	......	......	[1]4,647,883	[1]424,424
All other	......	......	......	960,264	......	......	......	......	......	1,555,908
Dyes and dyestuffs	......	576,830	......	......	......	1,526,942	......	4,661,173	......	[2]7,153,689
Aniline dyes	......	......	......	304.768	......	......	......	......	......	[1]801,874
Logwood extract	......	......	......	132,082	......	......	......	......	......	[1]337,106
All other	......	......	......	644,949	......	......	......	......	......	[1]1,221,528
Total, dyes and dyestuffs	......	576,830	......	1,081,799	......	1.526,942	......	4.661,173	......	9,514,197
Exported to—	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity	Value.	Quantity	Value
France	......	$22,360	......	$171,677	......	$28,519	......	$259,918	......	$677,461
Italy	......	25,985	......	94,646	......	258,680	......	636.516	......	1,198,546
Russia in Europe	......	23,562	......	1,700	......	7,480	......	357,556	......	59,383
Spain	......	27.631	......	64,527	......	15,804	......	203,217	......	844,024
United Kingdom	......	106,917	......	182.813	......	484,456	......	590,375	......	2,107,138
Canada	......	99,697	......	120,823	......	493,537	......	1,290,352	......	1,118.160
Mexico	......	8,837	......	62,233	......	919	......	108.534	......	475,347
Argentina	......	27,361	......	50,134	......	26,397	......	161,818	......	265,075
Brazil	......	37 769	......	75.588	......	7,991	......	132,849	......	1.029,697
British India	......	63,181	......	2,735	......	577	......	156,229	......	411,485
Japan	......	18,339	......	157,374	......	108.839	......	151,202	......	573,613
Other countries	......	115,191	......	97,549	......	93,743	......	612,607	......	754,268

[1] Figures cover period beginning July 1.

[2] Figures are for six months, January to June, inclusive.

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By Carleton Ellis and A. A. Wells.[*]

This Is the Eighth Installment of an Article Dealing with Investigations Conducted by the Writers Into the Possible Applications of Ultra Violet Light. The Present Installment Discusses Types of Apparatus Used for Sterilization and Other Purposes, Including Lamps Developed by von Recklinghausen, Keyes and Others. Part IX Will Appear in the December issue.

PART VIII

Types of Apparatus Used for Sterilization and Other Purposes.

Otto (French patent 421,296, Oct. 10, 1910) describes an apparatus consisting of a cylindrical vessel in the interior of which are placed clusters of lamps capable of emitting ultra violet rays. The water to be treated enters the cylinder at one end and leaves at the other. The lamps may be fitted into a movable chamber in the cylindrical vessel, so that faulty units may be repaired as required. The diameter of the cylinder may be reduced by means of plates at the points where the lamps are situated.

A mercury vapor lamp with quartz illuminating tube is described by *Gallois* (Bull. soc. encour. ind. nat., 121). In the initial position the mercury fills the illuminating tube, but when the current is started, a coil attracts an armature connected by a rod with the tube, and turns the latter on its axis about 40°, whereby in consequence of the shape of the tube the mercury is divided into two portions and an arc is formed across the intervening space. Quartz lamps are constructed to work under tension of 220 to 500 V., giving a candle power of 500-6600.

Quartz Filling.

Quartz pearls are recommended by Allgemeine Elektrizitats-Ges (German patent 283,484, May 20, 1913), as a substance which may be used for filling the space in which the condensation of mercury occurs in a high pressure mercury vapor lamp and which does not effect the working of the lamp. The pressure and therefore the candle power are thus claimed to be increased.

Cold Light.

A design of mercury vapor lamp yielding nearly cold light is described by *Daguerre, Medard* and *Fontaine* (Compt. rend. 157, 921-2, 1914), which is in the form of an inverted U-tube and is made of fused silica. Electrodes of invar enter the ends of the tube. A short intense arc is formed at the bend of the tube between the columns of mercury on either side. The lamp is enclosed in a transparent silica flask—the wall of which is paraboloidal and silvered to act as a reflector—and is immersed in a tank of water. The light is concentrated by the mirror and emerges through a silica window in the tank. The tank consumes 18 amperes either alternating or direct current at 70 volts and yields 3,000 candle power. The light is practically cold and can be used for microscopy and projection work without heating the specimens or celluloid films. It has the advantage over the carbon arc in that the luminous point remains fixed and requires no regulation. Its application to water sterilization and submarine photography is suggested.

Thallium and Caesium Lamp.

Cooper Hewitt (U. S. patent 1,197,629, Sept. 12, 1916) suggests the use of metals such as thallium and caesium in the manufacture of quartz mercury vapor lamps in order to increase the ultra violet efficiency. In the construction of this lamp, mercury is used in one end of the quartz tube and acts as the anode, while the other metal is placed in the opposite end of the tube and serves as the cathode. Inasmuch as thallium and caesium are solid at ordinary temperatures and difficulty would be experienced in starting the lamp, in case it were made in the same manner as a quartz mercury lamp, a connecting rod is inserted between the mercury and the cathode to assist in starting the lamp. When the heavy current is turned on the cathode becomes heated to such an extent that the metal becomes molten and partially vaporized, after which the operation of the lamp takes place in the usual manner.

Life of Lamps.

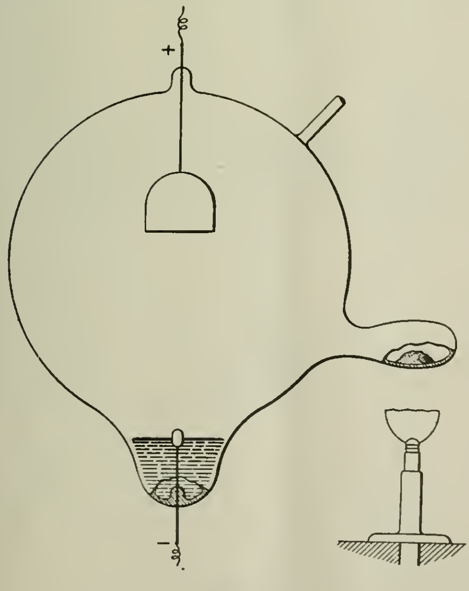
Evans (Trans. Illum. Eng. Soc., 8, 1913) describes in detail various types of quartz lamps and gives curves and drawings illustrating the principal electric and photometric characteristics. The average life of the 220 volt type is stated to be between 2,500 and 3,000 hours before being re-exhausted. Lamps can be re-exhausted about three times. The cost per 1,000 burning hours is estimated at $4 to $5. The applications of the quartz lamp to sterilization of water and milk, fixation of patent leathers, testing permanency of colors, etc., are discussed.

Absorption of Nitrogen.

In a method for improving the vacuum in electrical apparatus and more especially as applied to the quartz mercury vapor lamp *von Recklinghausen* (U. S. patent 1,110,576, Sept. 15, 1914) suggests the use of certain metals which have the property of absorbing nitrogen when heated to a high temperature. For this purpose magnesium, boron and titanium are proposed, the latter two being preferred. In the operation of this process the nitrogen occluding metals are introduced into the chamber in a solid or powdered form and means provided for raising them to the desired temperature. For example, in the construction of a mercury vapor lamp the nitrogen occluding metals are placed either in a small tubular projection blown in the vessel or they may be used in the form of bars and connected with an electric current. The mercury is placed in the chamber and the vacuum drawn in the usual way. Before setting the lamp in operation the nitrogen occluding metals are heated and in this manner the normal vacuum is increased. In case there is a leak in the vacuum seals allowing a small quantity of air to enter, thus decreasing the vacuum, it is claimed that the heat generated by the operation of the lamp will raise the nitrogen occluding metals to a temperature at which they will readily absorb the air which has entered the lamp due to leakage and thereby maintain the vacuum automatically.

---

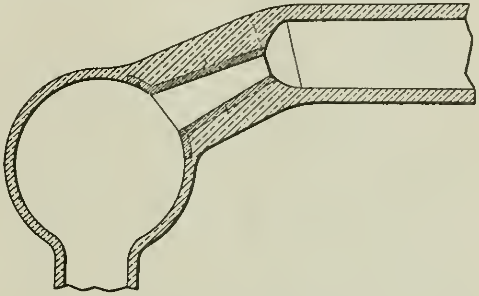
[*] All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, [illegible] 98 Greenwood Ave., Montclair, N. J.



Von Recklinghausen Nitrogen-Absorbing Lamp.

Preventing "Cathode Spot" Deterioration.

The effective life of a quartz mercury vapor lamp is increased by von Recklinghausen (U. S. patent 1,188,587, June 27, 1916) by reinforcing the quartz tube at the points which are subject to the greatest deterioration. There is a certain spot in lamps of the usual construction which von Recklinghausen calls the "cathode spot," at which point the concentration of the current and the exceedingly high temperature produced have a tendency to disintegrate or otherwise injure the quartz surface. As a remedy for this, von Recklinghausen proposes to line this portion of the quartz lamp with a highly refractory material such as "titanium zircon quartz" and thus to greatly prolong the life of the lamp. Inasmuch as this "cathode spot" does not remain stationary but is advanced or retarded according to the workings of the lamp, quite a considerable portion of a constricted surface as well as a portion of the condensing bulb is lined with this material. It is claimed that cracking and clouding of the quartz is obviated to a great degree by this method of construction.

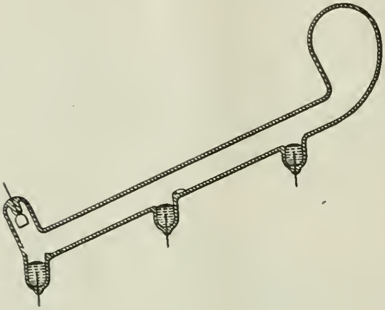


Von Recklinghausen Reinforced Lamp.

Mercury Distribution.

The proper distribution of the conducting fluid, in a mercury vapor lamp has been investigated by von Recklinghausen (U. S. patents 1,091,244, March 24, 1914, and 1,110,574, Sept. 15, 1914) who states that it is customary in some cases to use a series of electrodes in lamps of this type and that in these cases difficulty is encountered in maintaining the proper distribution of the electrode. In order to obviate these difficulties Von Recklinghausen proposes the inclining of the arc container, the condensing chamber being located at the top. The condensed metal flowing along the bottom of the tube fills each pocket in succession, the remaining metal overflowing and running along down the tube until the next electrode is reached. This pocket in turn is filled in case it is not already full, the overflow passing on to the next electrode. In an operation of this kind difficulty might be encountered, causing a short circuit, in case the entire bottom of the tube was covered with a stream of mercury. If, however, a weir is placed at the upper edge of the electrode pocket, the mercury will accumulate and flow intermittently from one pocket to the next, thus breaking any contact which might otherwise be formed. (See cut at top of page 30.)

Another type of apparatus using the same method of maintaining the mercury distribution consists of an arc container having two tubular extensions on the bottom side which dip into vessels containing a supply of mercury. These two vessels are connected by means of a small pump in order to transfer mercury from one vessel to the other. The positive pole is connected through one of these containing vessels, the negative pole being connected to the quartz chamber through an electrode pocket. As the metal is vaporized it condenses and flows into the electrode pocket and from here overflows and runs down into one of the chambers. Any excess or deficiency of mercury may be corrected from the receiving vessels. As in the previous type short circuits are prevented by placing obstructions just in advance of the electrode pockets.



Lamp with Arc Container Inclined.

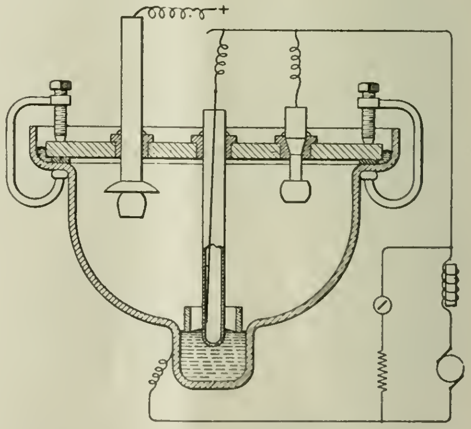
"Negative Electrode Flame" Effect in von Recklinghausen Apparatus.

In the construction of a vapor electrical apparatus, especially of a larger type, von Recklinghausen (U. S. patents 1,110,572, 1,110,573 and 1,110,575, Sept. 15, 1914) makes use of a metal chamber in which the negative electrode is in contact with the chamber and the positive electrode insulated away. Where an apparatus of this type must be maintained under high vacuum, difficulty is likely to be encountered. The mercury which is used as an electrode is contained in a small pocket located at the bottom of the chamber and the positive electrode, which may be of iron, is suspended through the cover. In operation, in case the vacuum becomes slightly imperfect, mercury tends to collect on the insulating tube and eventually cause a short circuit. This is obviated by carrying the temperature to such a point that the insulating tubes or a portion of them are heated to such a temperature that condensation is impossible. Another danger which is likely to occur is the "negative electrode flame," which has a tendency to attach itself to the solid portions surrounding the negative electrode, thus causing disintegration. In order to obviate this, von Recklinghausen inserts a porcelain ring in the cup containing the mercury, thus preventing the flame from attacking the metal. The material used in packing the joints of the vessel must be free from carbon, otherwise a small amount of carbon may enter the chamber and cause considerable injury. If, for example, asbestos is used, care must be taken that any binding material, such as rubber, be carefully burned out before use

R. U. V. Apparatus.

The ultra violet lamp used by the R. U. V. Company* is a clear quartz lamp and is produced for 110-volt and 220-volt direct-current operation, the 220-volt lamp being richer in ultra violet light than is the 110-volt lamp. Ultra violet rays range from 0.40u down to 0.10u; practically, however, only ultra violet rays between 0.40u and 0.22u are used. These rays are produced by the mercury vapor arc in great richness when it is operated at comparatively high temperatures obtained by higher voltages than are common to this arc, viz., about 70 volts for the 110-volt lamp and 170 volts for the 220-volt lamp. The needed ballast resistance for supporting such an arc reduces the line voltage to proper terminal voltages for the lamps.

To accommodate the temperatures and to offer little or no interference to the escape of the rays, fused rock crystals are used to make the quartz lamp. The mercury is hermetically sealed in the lamp after the vacuum is obtained; the seals being graduated from full quartz to glass in several steps, to permit maintenance of the seal and vacuum, by satisfying the two critical coefficients of expansion, i. e., those of the platinum wire connectors and of the quartz itself.



Vapor Electrical Apparatus Employing Metal Chamber.

The vertical cylindrical chamber forms the cathode and holds the mercury when the lamp is running, the anode being the tungsten button at the far end of the horizontal tube of the lamp proper.

To start the lamp, tilting is required to break the mercury bridge; this is done automatically or manually, according to the type of sterilizer. Immediately upon tilting, the arc is struck and the mercury is vaporized, and pressure is built up which pushes the mercury back into the vertical cylindrical chamber. While running, the mercury is continually vaporized and condensed.

The lamps are protected in starting by an automatic device which operates in series with the lamp;

---

*50 Broad St., New York.

at first current is passed through all of the ballast resistance provided until a certain amperage is reached, whereupon automatically a solenoid drops and cuts out resistance to the proper amount for correct running conditions. Should service be interrupted, this device automatically safeguards the lamp.

Automatic tilting of the lamp is effected in somewhat a similar manner. At the instant current is supplied to the lamp a magnet coil connected in series with the lamp is energized, and by this means the lamp is raised into its running position, thus striking the arc. All ballast is in series at the time of starting, but will gradually be partially cut out.

Lamp-starting current demands are about 100% over the running load; electrical equipment correlated with the sterilizers should be able to maintain this overload for 15 to 20 minutes, though actually the overload is drawn in an initial and a succeeding peak and both gradually reduce to running current load. This applies particularly to motor generator sets furnished to transform available electric service to lamp requirements. With either the 110-volt or 220-volt lamp, voltage regulation must be within 5% above or below the stated figure.

To transmit the ultra violet light to water for sterilizing the latter and to prevent heat exchange from the lamp to the water, a quartz protecting tube is used. Glass is unavailable, since it is practically impervious to ultra violet light. This quartz tube is inserted in the sterilizer and inside it is placed the lamp. The water to be sterilized is passed around the tube. The tube is made watertight by stuffing-boxes packed with rubber and protected by aluminum heat rings.

The problem of producing automatic apparatus for sterilizing water involves both sanitary as well as electrical and mechanical requirements. Since time is required to bring the lamp into running condition from a cold start, or of returning it to running condition from stoppage due to possible current interruption, etc., it is necessary that no water flow through the sterilizer during such periods. These conditions are easily satisfied by a solenoid valve in the water line and two simple relays, one a series, the other a shunt, in connection with the lamp circuit.

The series relay closes the line to the shunt relay at a certain current demand by the lamp; the shunt relay, then free to operate and in shunt with the lamp itself, closes the line to the solenoid valve when a certain voltage has been reached, which means proper running conditions have been obtained, whereupon the water line is opened up and water flows through the sterilizer. Either interruption of electric service, failure of lamp, or incorrect operation of the latter will close off the water line by de-energizing the solenoid valve via either one or both of these relays.

Tungsten Arc Lamp.

An enclosed tungsten arc lamp suitable as a source of ultra violet light, and designated the Quartz Pointolite Lamp, is described by *Morphy* and *Mullard* (J. Rontgen. Soc. 12, 70-4, 1916; Chem. Abs. 1917, 235). In the operation of this lamp a tungsten filament, which also forms the electrode, is heated by a shunt circuit which is closed temporarily when the lamp is switched on. The ionization of the gas brought about by the hot filament permits a current to pass across the gap to the tungsten globule which forms the other electrode, thus striking the arc, which can then be maintained indefinitely. When the lamp is run with a sufficiently high current the output of ultra violet light is of the same order as from the open tungsten arc and the objections of unsteady working and the production of white fumes of tungsten oxide are avoided.

Tungsten and Nickel Electrodes.

To weaken the spark obtained by a metallic arc, *Kowalski-Wirusz* (Fr. Pat. 468,215, Feb. 5, 1914) proposes electrodes of nickel, tungsten or their alloys, either alone or in combination with rare earths. By an appropriate choice of electric constants, and employing a wave length of less than 300u a great amplitude of current intensity is obtained. The ultra violet rays, produced on sparking, may be used for sterilizing liquids. The efficiency is increased by using different materials for the two electrodes and plunging them into the liquid to be treated. For the production of chemical reactions where the gases formed by electric action would be objectionable, a screen, such as quartz, may be interposed between the source of light and the material under treatment.

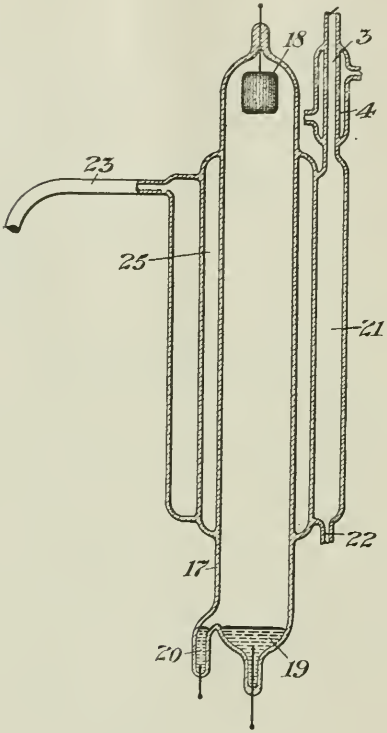
Apparatus for Chlorination.

Keyes (U. S. patent 1,237,652, August 21, 1917) describes an apparatus for the catalytic synthesis of organic substitution products especially for the production of chlorine or bromine derivatives of hydrocarbons. In the figure (p. 32), 17 is a tubular portion of a mercury vapor apparatus having a quartz container, an anode 18, a mercury cathode, 19, and a starting anode 20. This vapor apparatus is surrounded with a jacket, 21, having an inlet, 22, and an outlet, 23, a vent, 3, and a condenser 4. The tube 17 may be surrounded with a jacket, 25, which jacket may be exhausted. All the parts except the electrodes, may be made of quartz. This apparatus is adapted to continuous operation. In operation, halogen mixed with a hydrocarbon are fed at the inlet, 22, and pass up and around the tube 17, being acted upon as they pass by the radiations produced by the current and finally being delivered to the outlet 23. With the vacuum jacket around the tube, 17, the liquids passing through the jacket, 21, are protected from the heat produced by the lamp. Two other modifications of the apparatus are also shown.

Lamp for Treating Liquids or Gases.

In a process described by Ges. Quartz-Lampen

(British patent 13,624, Sept. 24, 1915; Chem. Abs. 1917, 412) liquid or gas is passed through a jacket formed by coaxial tubes and closely surrounding a mercury vapor lamp. The inner tube of the jacket is of silica or other material transparent to the active radiation; the outer tube may be of material which reflects the radiation. The lamp container and inner tube are conically ground to fit together near their lower ends, and if desired, near their upper ends also; in the latter case the narrow intermediate space may be exhausted. To reduce absorption by the mercury, the discharge is driven towards the container by electro-magnets which form a series resistance for the lamp and may be arranged in a helical row. As the discharge is thus given a helical form, the liquid or gas may be directed in a similar path by baffles or by a helical groove in the outer wall of the jacket.



Keyes Apparatus for Chlorination.

Ozonizing Apparatus.

Davis (U. S. Pat. 1,209,132, Dec. 19, 1916; Chem. Abs. 1917, 549) subjects air to violet and ultra violet rays and partially ozonizes it by exposing it between a thin silica plate supported on an iron plate, and a glass disk, having an overlying layer of carbon. The iron and carbon plates are connected to terminals of an electric circuit and air is drawn between the plates by a fan. Spacing blocks of insulating material separate the silica and glass plates. An alternating current is preferably used, as it is stated to cause the impurities in the air to separate and collect upon the surfaces of the plates.

Bovie (J. Biol. Chem. 20, 315-20, 1915) describes simple quartz mercury vapor lamps for biological and photochemical investigations. Directions are given for making lamps of various types in the laboratory, which are useful in experiments on the biological and chemical effects of ultra violet light.

Apparatus for Producing Very Short Wave Lengths

It is noted by Tian (Compt. rend. 156, 1063) in experiments on the effect of ultra violet light on water, that the endothermic combinations produced by rays of very short wave length (1900 Angstrom units) are often destroyed by the other ultra violet radiations. In making ozone or in other processes which use the very short waves it is necessary to avoid those rays which tend to restrict the reaction. When quartz lamps are used they must be operated at a low voltage as the total emission of ultra violet light increases greatly with the voltage while the energy of the rays shorter than 1900 varies much less. Tian describes a lamp made of a tube of transparent quartz down the center of which an insulated iron wire passes, thus making contact with a drop of mercury at the bottom, which forms the cathode. The anode is a small iron cylinder. Ordinarily direct current is used, but alternating current may be used if the anode is made double, i. e., two plates separated by a sheet of mica. The special advantage of this form of lamp besides operating at low voltage is that it is of convenient form to immerse in liquids.

Billon-Daguerre (French patent 419,117, Oct. 18, 1909) uses Geissler tubes constructed of silica and containing more or less rarefied gases for the production of hyper-ultra violet rays of short wave length. Several forms of lamp are described which may be provided with a vacuum jacket. When a liquid is to be sterilized it is passed in a thin layer over the surface of the lamp, or is conducted through tubes where it is subjected to the action of the rays emitted from the lamp.

Use of Resonance Transformer.

Kowalski (Compt. rend 158, 1337-9; Bull. Soc. Int. Elec. 4, 437-50) shows that the region of maximum radiated energy is displaced towards the longer wave lengths as the oscillatory current is increased. Increasing the amount of energy consumed in the spark, however, causes displacement toward the shorter wave lengths, but this displacement is dependent in a degree upon the nature of the electrodes. The intensity of the mean ultra violet ray, used in photochemical reactions and in sterilization, varies inversely with the frequency. A definite relation can be established between the number of sparks per second, capacity, and frequency of the primary current, if a resonance transformer is used, and thus it is possible to determine the most economical conditions for working the lamp.

Effect of Cooling.

Henri (Comptes, rend. 1911, 153, 426), during experiments on the ultra violet radiation from a mercury vapor lamp has shown that the radiation becomes more intense as the temperature of the luminous tube is allowed to rise. By cooling the tube with water, the radiation was found to be 14 times less powerful than with air, the same number of watts being consumed. The yield seems to depend on the fall of potential in the luminous tube. Quartz mercury vapor lamps have proved to be a very constant source of ultra violet rays and one in which the radiation is definite when the voltage, amperage and length of the tube are known.

Method of Cooling Lamps.

According to *Weigert*, (Z. physik. Chem., 1912, 80, 67) the quantitative study of photochemical gas reactions under the influence of ultra violet radiation is rendered difficult by the temperature effect produced when the lamp is in action. Attempts to avoid this by water cooling usually involve the passage of the radiation through a layer of water where it is largely absorbed. In the Weigert's apparatus, which is water cooled, the reaction takes place in a vessel outside the lamp itself, but the reaction vessel receives radiation which has only passed through such non-absorbing media as quartz and hydrogen.

Tubular Treating Apparatus.

In treating liquids with ultra violet light *Kowalski-Wierusz* (French patent 468,216. Feb. 5, 1914) sprays the liquids to be treated into a series of vertical tubes by means of compressed air or steam. These tubes are arranged about a lamp emitting ultra violet rays and have their lower ends connected with a collecting vessel. In another form of apparatus the liquid is sprayed directly into a chamber containing the lamp. Oil, or oil mixed with oxygen before being submitted to the action of the rays, may be treated in this manner to secure a bleaching effect.

Cadmium Vapor Arc Lamp.

Sand (Elec. Rev. West. Elec. 67, 654; Chem. News 112,151, 1915) describes a cadmium vapor arc lamp the use of which is recommended for polarimetric and other purposes, which is comparable in general principle with the mercury vapor lamp. The lamp is constructed of quartz glass. The cadmium is freed from oxide and dissolved gas by a process of filtration while at the pump. It is hindered from adhering to the glass by the presence of a small amount of a loose powder (zirconia) in the lamp. The metal is melted by external heating before starting, and maintains itself in the molten condition by the heat of the current. Once started, the lamp may be kept burning for an indefinite time.

Ray Filters.

Norsk Hydro-electrisk Kvaelstofaktieselskab (Norwegian patent 27,363, Oct. 23, 1916; Chem. Abs. 1917, 280), in a process for effecting chemical reactions between gases by means of ultra violet rays, use a ray filter for shading off ultra violet rays, so that only those wave lengths come into action which produce the desired reaction.

Light-Filter Used in Observations on Fluorescence and Phosphorescence.

A filter for ultra violet rays used by *Lehmann* (Physik. Zeits. 1910, 1039. Chem. Zent., 1911, 1, 55) consists of a vessel of Jena blue "uviol" glass filled with copper sulphate solution, and coated on the outside with a preparation of nitrosodimethylaniline and gelatine. A quartz lamp or an iron arc is used as the source of ultra violet rays and lenses of quartz of "U-V" crown glass for concentrating the rays. In describing the possible applications of such a light filter, it is pointed out that on exposure to the rays, chemically pure substances exhibit luminescence only faintly, whereas commercial products of second quality show a very strong luminescence. Different types of glass each exhibit characteristic fluorescence-colors. Many substances exhibit notable phosphorescence; rods of fused sodium hydroxide, for example, show a reddish-white effect in the cone of ultra violet rays, and a green color when rapidly moved away.

Detection of Metals.

Andrews (Gen. Elec. Review 1916, 317) describes an apparatus for the production of ultra violet rays for the detection of various metals. Andrews proposes the use of electrodes of iron, zinc, cadmium, magnesium, nickel, cobalt, etc., stating that some of these produce great intensity of ultra violet rays in certain regions of the spectrum but that for general work iron is more satisfactory because the length of the rays produced are more uniformly distributed throughout the entire range. Andrews states that when the wave lengths which are invisible to the eye fall upon certain substances, these substances are excited and show fluorescence, that is, reflecting the light in the visible spectrum. Some substances, such as barium sulphide continue to glow for some time after being excited, while others merely show the effect while the ultra violet light is shining upon them. Andrews proposes a method of determining whether the lens of ordinary spectacles or eyeglasses are of the proper material to protect the eyes by inserting the lens between the source of light and a metal which shows fluorescence. If the fluorescence continues the lens is not impervious to ultra violet rays. Various substances show different colors when exposed to ultra violet light, for example, calcite shows red; barium sulphide, orange; cadmium compounds, yellow; willemite, green; salts of salicylic acid, blue; some compounds of calcium, violet.

Ultra Violet Light Absorption by Glass.

The absorption of ultra violet light by various kinds of glass was investigated by *Ham*, *Fehr* and *Bitner*. (Penn. State College Report 1914, Part I, 158-62, published 1916) for the purpose of finding suitable protective glasses for the eyes. It is concluded that glass is opaque to wave lengths below the 302 line and therefore the rays which are generally conceded to be the extremely harmful are cut out. Until more data is obtained it is recommended that those glasses which do not absorb almost completely the 365 line should be rejected. The method of testing is given in detail.

Protection of the Eyes from Ultra Violet Rays.

The Seaman gold medal, which is annually awarded for progress in the promotion of hygiene, has been conferred upon the Julius King Optical Company, for research in overcoming the harmful effects of ultra violet and infra red rays of light in connection with arc-welding and other industrial processes at very high temperatures. (J. Ind. & Engr. Chem., 1917, 683.)

Any light source over 2000°F. is a distinct menace, and when a temperature of 6400° is reached, such as is encountered in electric carbon arc-welding, the volume of ultra violet radiation is so great as to impair vision permanently. Until an investigation was made about three years ago, practically 90 per cent. of all colored glass in goggles for industrial use was incorrect.

One of the first forms of eye protection from glare was the wearing of blue glasses in the manufacture of steel, particularly in the open-hearth process. Glare is made up of non-injurious rays of the spectrum, namely, green, yellow, orange and red rays. As a matter of fact, blue is stated to be one of the worst colors which could possibly be selected, as it allows ultra violet, violet, blue and also infra red rays to enter the eyes, cutting out only that part of the light which is essential to vision, but affording no protection from dangerous light.

A temperature of 2000° F. requires a lens but slightly tinted, while a temperature of 6400° requires a lens so dark that one can barely see the sun through it. The Julius King Optical Company has plotted all colors on a photometric scale, the standard adopted being a white cloud illuminated by the sun, which may be looked at indefinitely without eyestrain. A temperature of 2000° of molten iron through a slightly tinted glass has the same effect as if the wearer had nothing over the eyes, and was looking at a white cloud. The same photometric standard applies in looking at a temperature of 6400° through the darkest glass, the effect on the eye being the same.

The process of arc-welding requires protection not only for the eyes, but for the entire face and neck. Welders have experienced such intense eye strain and face burns after a few minutes' work, that all sorts of crude shields have been devised. The majority of these, however, were heavy and cumbersome, being made of metal and leather.

Since metal is a conductor of heat and electricity, the Julius King Optical Company have constructed a helmet of fiber, finished within and without in dead black so as to minimize the danger from reflected light. The top of the head is protected by a fireproof cap, to which the helmet is pivoted so that it may be turned back out of the range of vision when it becomes necessary for the wearer to inspect his work or to move about. The lenses mounted in this helmet are a combination of "Ark-weld" and "Akopos" glass, the former to reduce the intensity and the latter to eliminate the injurious rays of the arc light.

Illuminating Value of the Quartz Mercury Vapor Lamp.

Clewell (Electrical World, 1109, 1917), in a discussion of modern lamps and their application in the solution of lighting problems, considers the quartz mercury vapor lamp. He states that by virtue of the high candle power rating of these lamps as compared with other types, and for lighting large areas having the source of light on high poles such as for yard lighting, the quartz mercury arc lamp is very efficient; a glass globe used in connection with these lamps cuts off the ultra violet rays and thus provides a very efficient and safe source of light for these uses.

(To be continued in the December issue.)

Postal Savings Deposits Will Not Be Seized by the Government.

Postmaster Patten invites attention to the information contained in the following important notice which is of special interest to the public:

Some misapprehension seems to exist relative to the status under the trading-with-the-enemy act, of citizens or subjects of Germany or its allies resident in this country. Such persons are not included within the term "enemy or ally of enemy" as employed in the act. Deposits in the postal savings banks of the United States belonging to such persons are not liable to seizure by the Government, and will not, therefore, be taken into the possession of the alien property custodian or be interfered with in any way whatever.

(Official Bulletin, Washington, D. C., October 30, 1917.)

Order Department, P. O., New York, N. Y. November 2, 1917.

High Products Chemical Co.

With a capital of $500,000, the High Products Chemical Company has been incorporated at Newark, N. J., to manufacture chemicals and kindred products. The incorporators are Carl Dorgschlag, William Gerlach and H. C. Pfaff, Newark.

Walker Chemical Co.

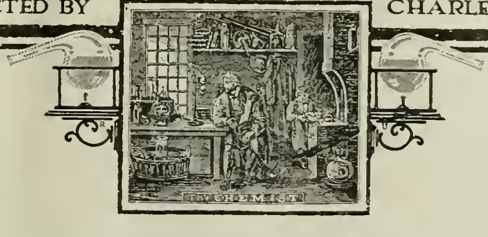
The Walker Chemical Company, Philadelphia, Pa., has been incorporated under the laws of that state to manufacture chemicals. The capital is $10,000 and the incorporators are F. R. Hansell, Philadelphia, and S. C. Seymour, Camden, N. J.

Hudson on Semet-Solvay Board of Directors.

Alfred W. Hudson, president of the First National Bank of Syracuse, N. Y., has been elected to the board of directors of the Semet-Solvay Company, that city, to succeed the late Frederick R. Hazard.

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.



ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

A. S. T.—I am sorry to have kept you waiting so long for an answer, but your question required considerable investigation and research and, as there were a number of letters ahead of yours, the delay was unavoidable. Nevertheless, it will appear in the next issue.

W. T. T.—If you will forward me samples of your porcelain, I will submit them to the following tests:

1. Resistance of glaze to chemical action.
2. Fusion point.
3. Chemical composition.
4. Translucency.
5. Effect of repeated heating and cooling.
6. Effect of sudden cooling.

As this type of work requires special care and considerable time, a small fee must be charged, depending on the number of samples, etc.

W. G. R.—As I have mentioned in these columns before, a paint containing more than one per cent of water will not dry readily. You had better ship me a sample from your stock so that I may determine the water content and also if the solvent is such as may cause trouble. For this class of test a small fee will be charged.

A. I. S.—The coke-oven benzol you mention is composed chiefly of toluene, benzene, paraffin, xylene and bisulphide of carbon, most of which will pass over at 171°C.

If you will send me these fractions I will determine the various constituents. Samples of about one pint should be forwarded.

Dr. F. S.—Brilliant Green, the anilin dye, is now being used extensively for wounds. Its chemical name is Tetraethyldi-fi-Aminotriphenylcarbidride Sulphate, zinc double chloride, or rarely oxalate. All are lustrous and brassy yellow in color, and soluble in alcohol and water.

The allied brands are:

Brilliant Green.
Malachite Green G.
Diamond Green G (B).
Emerald Green.
Fast Green.
Ethyl Green.
New Victoria Green.

These are usually employed for dyeing silk, wool, leather, etc., but have lately come into use in surgery, chiefly on account of the war.

I. W. C. Co.—A ductile filament can be produced by starting with a powdered refractory metal, sindering in atmosphere of hydrogen and vapor of tungsten halogen salt, at high temperature.

The tungsten salt will fill the minute spaces in the powdered metal, and a solid massed body obtained which can be worked into filaments with the present machinery you now have.

W. S. A.—The sample of dental porcelain you submitted for rational chemical analysis was found to have the following composition:

Feldspar	60.91
Clay	1.02
Flint	25.00
Quartz	4.50
Bone Ash	1.60
Sodium Carbonate	0.75
Calcium Carbonate	2.25
Potassium Carbonate	0.82
Borax	3.15
	100.00

Charles B. Davis.

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail are specifically requested, communications can only be considered in the order of their receipt.—Editor.

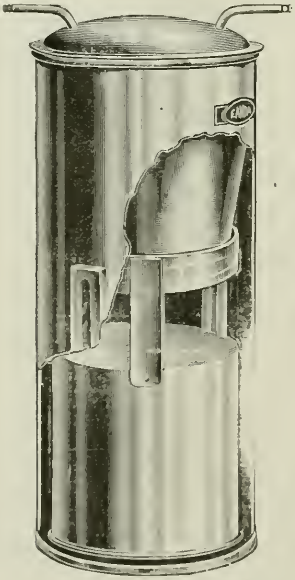
NEW APPARATUS

Conducted by F. W. S.

From month to month the newest forms of apparatus of interest to chemists and chemical engineers will be described and illustrated in this department. Information as to where various articles can be purchased may be obtained by addressing The Chemical Engineer, 118 East Twenty-eighth Street, New York City.

The Plaisance Extraction Apparatus.

Below is pictured a new form of extraction apparatus designed by Professor Plaisance of Iowa State University. It is intended for the extraction of larger quantities than are ordinarily used in the laboratory. As manufactured in the stock size, the inner vessel has a capacity of about two quarts and the outer vessel about two gallons. However, this apparatus can be made in any size desired. The stock apparatus is of heavy copper, but any other available metal can be used. The apparatus is particularly recommended for the extraction of herbs and flowers, general food work, asphalt and rubber extractions, etc.



Plaisance Extraction Apparatus.

New Plant for Linde Air Products.

The manufacture of oxygen and other air products in a new plant at Norfolk, Va., is contemplated by the Linde Air Products Company, New York City. The firm has already acquired a site at Norfolk for the erection of a plant for this purpose.

An Optical Pyrometer for Works Use

For the measurement of temperatures above 1400° F., only two methods have been found practicable for works service. One of these is based on the thermocouple, used either with the millivoltmeter or with the more accurate and reliable potentiometer. The other method is based on the laws of radiation and includes both the radiation pyrometer and the optical pyrometer, which utilizes only that radiant energy visible to the human eye.

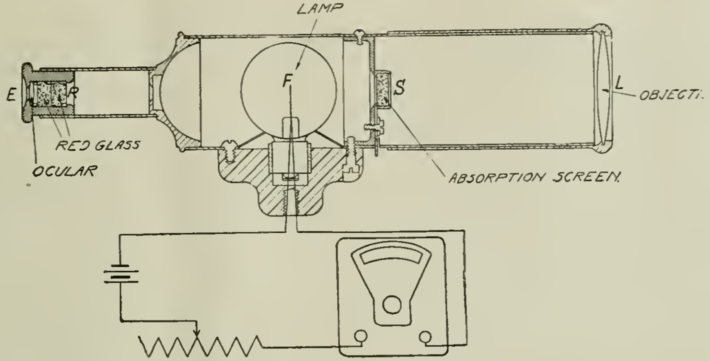
For many services the inexpensive and sturdy base-metal couple may be used for accurate measurements up to 2000° F., with entire satisfaction; the more fragile and expensive platinum couple may be used up to 2800° F., but the thermocouple, like thermometers in general, must assume the temperature of the hot object by convention, conduction, radiation, or all combined. This fact militates against its use for measuring the temperature of molten brass, iron and other metals, or for measuring temperatures in gas producers and other locations where the

The Leeds & Northrup Optical Pyrometer in Use.

thermocouple would be subjected to rough mechanical treatment or to contamination by vapors and gases, which would rapidly impair its accuracy. In many industries the temperatures used are far above the range of thermocouples.

Measurement by Light Radiation.

Measurements by radiation can be carried out at a distance, once the laws connecting temperature of radiating body and intensity of radiation have been determined, and the radiation receiving and measuring part need not be heated to the temperature of the radiating body, nor even anywhere near to that temperature. Pyrometers utilizing radiation are divided into two classes, those which measure as heat energy and the total radiation falling upon the receiving part of the instrument, and those, known as optical pyrometers, which are based upon the fact that the luminous radiation or light varies in a definite manner as the temperature of the hot body changes.



The greatest success has been attained by separating out one kind or wave length of radiation, usually that which excites the sensation of red, and comparing the intensity of this one-color light with the intensity of the light of the same color emitted by a standard source of light. The eye is very sensitive when comparing the brightness of two surfaces when one is superposed upon the other, and after having arranged to have light from the hot body and light from the standard of comparison viewed in this relation, they can be made equal, either by varying the amount of light received from the incandescent object, or by varying the intensity of the standard of comparison.

The latter method, that is, variation of the intensity of the standard of comparison, is preferred and used by the U. S. Bureau of Standards, also by the Reichsantalt, of Berlin, where its practical application has been brought to a high degree of perfection by Messrs. Holborn and Kurlbaum. The Leeds & Northrup Co., of Philadelphia, working under the fundamental Morse patents, has lately carried on a prolonged investigation and development of this type of optical pyrometer with a view to realizing a high degree of accuracy and reliability in a simple and portable device. The instrument, which is illustrated herewith, is suitable for measuring from dull red (about 1100°F.) up to the highest known temperature.

The manner in which the luminous radiation from the hot body is balanced against that from the standardized source will be understood by reference to the accompanying figure.

Description of Pyrometer.

L is a lens by which rays from the hot body at C are brought to a focus in the plane F, where there is located a tungsten lamp filament. By means of the eye piece E, the observer views the incandescent filament, which appears to lie upon the image, just as the cross hairs in a surveyor's telescope appear upon the distant object looked at. By means of a rheostat in a case slung about the neck, the case also containing a storage battery and a milliammeter, the current through the lamp is adjusted until the brightness of the filament is just equal to the brightness of the image produced by the lens, that is, so that the filament blends with, or becomes indistinguishable upon, the background formed by the hot object. The observer than notes the reading of the milliammeter, which may be provided either with a special scale to read in degrees of temperature, or the temperature corresponding to the current may be read from a calibration curve supplied with the instrument.

The adjustment is made with great accuracy and certainty, as the effect of radiation upon the eye varies some 20 times faster than does the temperature at 1300°F., and some 14 times faster at 3400°F., while as above stated, the eye is very keen in distinguishing differences in brightness between superposed objects.

At high temperatures the light emitted by both the hot body and the filament would become dazzling, and comparison would be difficult. For this reason a red glass is placed in the eye piece at R, which has the further advantage that light of only one color then reaches the eye and no difficulty is introduced by lack of color identity between the light emitted by the hot body and that emitted by the filament. The intensity of light radiation of any one color increases progressively in a definite manner as the temperature of the radiating body rises, and nothing is therefore lost by eliminating all other light from the comparison. As only brightness, not color, of light is matched, inability to distinguish colors, and color-blindness, do not interfere with the use of the instrument.

Brightness of Image Is Constant.

The brightness of the image of the hot body produced by the lens L is almost absolutely constant, irrespective of the distance from the hot body, although the size of the image varies with the distance. Since it is the brightness of the image and not the total radiation received through the lens that is measured, it is possible to measure the temperature of a small body or of a body at a distance equally as well as that of a large body or of one near at hand. It is not at all necessary that the hot body should fill the entire field of view of the instrument, as with total radiation pyrometers.

In observing bodies at very high temperatures, as 2,500° to 10,000° F., the light received through the lens would be too blinding for direct observation, even through the red glass of the eye piece, and the intensity of the image might also become greater than that at which it is practicable to burn the tungsten filament, so that a balance would become impossible. Some method for reducing the intensity of the light from the hot body, such as by varying the aperture through which the light is received or by placing a screen to intercept some of the light, is therefore necessary. A screen is used, placed between the lens and the image, so that it reduces the light from the hot body, but not that from the filament. With the reducing screen it is possible to make direct observations of the most brilliant light sources, as the electric arc or the surface of the sun.

Application of Wien's Law.

It is not feasible to calibrate the instrument at such high temperatures by direct comparison, since they are above all known melting points and the ranges of contact thermometers, but fortunately a relation has been found to exist between temperature and intensity of radiation of any one color or wave length of light. By making use of this relation, known as Wien's Law, and reducing the intensity of the image in a known ratio by means of the screen just referred to, it is possible to extend the scale of the instrument to the highest temperature. The scale thus obtained has been found to agree very closely with a scale of temperatures established by known facts about the relation between temperatures and total radiation. In other words, this form of optical pyrometer gives the same scale of temperature as do total energy pyrometers used with the precautions necessary to secure accuracy and precision in the measurement of total radiation.

Use of the Absorption Screen.

The screen used for cutting off part of the radiation from very hot bodies can be thrown into or out of the field of view by means of a milled disk projecting through an opening in the tube of the instrument. With the absorbing screen in use, a different milliammeter scale or calibration curve is required, but as the range of the instrument without the absorbing screen overlaps many hundred degrees with the range for the absorbing screen, the accuracy of the two scales can always be checked by observing a hot body whose temperature lies within this range.

The readings obtained with this instrument are always the same for the same temperature, if the body viewed is surrounded by other objects, such as the walls of a furnace at the same temperature. Also no correction is required in the case of so-called "black bodies," such as incandescent carbon, when viewed in the open. For iron and steel in the solid state, the corrections required for readings taken in the open are also negligible.

Objects having a metallic sheen, that is, a surface which reflects light freely, as molten metal or polished platinum, do not give the same readings when viewed in the open as when viewed in the furnace, or as a black body would give with this or any other radiation or optical pyrometer. The readings, however, are always consistent for the same material under the same conditions.

Preparation of the Lamp.

The instrument can be calibrated by sighting it upon bodies whose temperatures are known, either by means of a thermocouple pyrometer, or by the melting or freezing of various substances. The constancy or reliability depends upon the constancy of the lamp, that is, its ability always to shine with the same intensity when receiving the same current. This matter has been investigated exhaustively by the U. S. Bureau of Standards and by the Nela Park Laboratory of the National Electric Light Association, also in the laboratory of the Leeds & Northrup Co., and it has been found that after a tungsten filament is thoroughly aged, that is, burned for some time at a temperature higher than that to which it will be subjected in service, no sensible variation thereafter occurs. The instrument is so designed that one lamp can quickly be replaced by another, and by keeping two lamps, their correctness can always be insured by checking one against the other.

The instrument itself is handy and portable, weighing only a few ounces, and can be sighted as easily as an opera glass. The case, containing the battery, rheostat and milliammeter, is designed to be slung about the neck, and weighs about 10 lbs.

FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Aniline Colors.

25353.—An agency is desired by a man in Argentina for the sale of aniline colors. Correspondence may be in English. References.

Refractory Materials.

25428.—An Italian gas company wants to buy large quantities of refractory material and articles connected with repairs in this industry. Correspondence may be in English. References.

Sulphur and Copper Sulphate.

25285.—A man in France wishes to buy sugar, dried vegetables, sulphur, sulphate of copper, lard and bacon. He also desires to entertain an agency proposition for the sale of these goods. Correspondence should be in French. References.

Calcium Carbide and Gas Generators.

25505.—A firm of India desires to be placed in communication with American manufacturers and exporters of electrical accessories, wire and cables, high-pressure kerosene-oil lamps, gas generators, carbide of calcium, petroleum, all kinds of stoves, pocket lamps, novelties, etc. References.

Chemicals.

25408.—The agency for hides, leather, belting, cocoa, coffee beans, sugar, iron, steel, copper and chemicals is desired by a Norwegian importer. Correspondence may be in either Norwegian or English.

Chemicals, Magnesium Chloride, Zinc Chloride.

25527.—A company in India wishes to be placed in communication with American manufacturers and exporters of piece goods, machinery, gin stores, hardware, dyes, colors, belting, grease, oils, lanterns, lamps, electrical goods, drugs, chemicals, patent medicines and drugs, wire nails, rosin, alum, rubber tubes, rubber sheets, asbestos packing and sheets, bobbins, bolts, nuts, hose pipes, rubber hose wire protected, cotton ropes, yarns, magnesium, chloride, zinc chloride, farina, files, tools, shovels, canned goods, wire netting, long cloth, drill, mosquito netting, flannel, etc., with a view to securing an agency for the sale of these goods. References.

Kerosene, Benzine, Benzol.

25471.—An agency is desired by a commission merchant in Spain for the sale of kerosene, lubricating oils, benzine, benzol and animal oils, including whale oil. Correspondence should be in Spanish. References.

Chemical Laboratory Outfit.

25351.—A foreign Government desires to purchase a chemical laboratory outfit to be used in connection with public instruction in chemistry or physics, and for analyzing food, drugs and other products. Quotations should be made f. o. b. New York or San Francisco. Goods should be very securely packed. Full information should be submitted. Correspondence should be in Spanish. References.

Dyes and Chemicals.

25529.—A company in India desires to secure an agency for the sale of cotton, woolen and mercerized piece goods, yarn, metal, hardware, glass and enamelware dyes, chemicals, paper, stationery and general sundries. Payment will be made against documents at 30 or 60 days' sight, if documents of acceptance is not practicable. References.

Chemical and Pharmaceutical Supplies.

25503.—An agency is desired by a commission merchant in Spain for the sale of patent medicines, remedies for animals and chemical and pharmaceutical supplies. Correspondence should be in Spanish. References.

Gasoline, Oils, Drugs and Chemicals.

25523.—A commission and shipping house in the United States, acting as agent for several foreign firms, desires to receive quotations from American manufacturers and exporters of petroleum, gasoline, asphalt, lumber, automobiles, cement, galvanized-iron sheets, iron bars for cement construction, agricultural implements, forage presses, wrought-iron pipes, textiles, provisions, flour, boots and shoes for women, drugs and chemicals, hardware, electrical supplies, paper, office supplies, men's furnishings, rope and twine, matches, lumber, cement machinery, lubricating oils, all kinds of leather and shoemakers' supplies and paint. Catalogues and samples should be submitted wherever possible. References.

DISTILLATES

News Notes of Chemical and Allied Industries

New Fertilizer Plant.

Swift & Company, Chicago, Ill., will expend $500,000 on the construction of a new fertilizer plant at Hammond.

Dr. Stevenson a Captain.

Dr. Reston Stevenson, assistant professor of physical chemistry in the College of the City of New York, has been commissioned a captain in the Sanitary Corps, U. S. A.

Addition to Chemical Plant.

The American Agricultural Chemical Company, Boston, Mass., is working on the construction of a one-story addition to its Portsmouth, N. H., chemical plant.

Newton Now With Falkenberg & Laucks.

Announcement has been made that Harry W. Newton has joined the staff of Falkenberg & Laucks, chemists and metallurgists, Seattle, Washington.

Penn Chemical Co. Adds to Plant.

The Penn Chemical Company, Philadelphia, Pa., has begun work on the construction of a one-story addition to its plant. The improvements will cost $25,000, the size of the addition being 25x45 feet.

Agricultural Chemical Co.

With a capital of $10,000, the Agricultural Chemical Company, Memphis, Tenn., has been incorporated under the laws of that state to manufacture chemicals and kindred products by Henry L. Sanders, F. E. Brown, J. B. Kelly, Memphis, and others.

Dr. McKee to Instruct Columbia Post-Graduates.

Dr. Ralph H. McKee has been appointed to take charge of the graduate work in industrial organic chemistry (Department of Chemical Engineering), Columbia University. Dr. McKee was for seven years head of the Department of Chemistry, University of Maine, where he accomplished the creation of the department for the making of pulp and paper, the first of its kind to be established in any college in the country.

Singer-Perlstein Company.

Philip A. Singer and Harris Perlstein have together formed the Singer Perlstein Company, chemical and industrial engineers. Both men were formerly of the Industrial Chemical Institute of Milwaukee. Mr. Singer is chiefly known for his research work in connection with the recovery of ethyl alcohol from wood paste, and Mr Perlstein has been associated with him in a number of recent enterprises. The offices of the new firm are in the Railway Exchange, Milwaukee.

Butterworth-Judson Adds to Plant.

At a cost of $10,000 the Butterworth-Judson Company, Newark, N. J., manufacturers of chemicals, will erect a one-story addition to the plant on Avenue R.

California Firm to Build New Plant.

The Butters Syndicate, Martinez, Cal., has acquired the plant of the Peyton Chemical Company and is completing the construction of a new plant for the manufacture of chemicals.

Motion Picture Films.

Motion picture films will be manufactured by the recently incorporated Betzwood Film Company, Philadelphia, Pa. The incorporators are F. R. Hansell, Philadelphia; J. V. Pimm and S. C. Seymour, Camden, N. J.

$1,500,000 Silica Corporation.

The Commonwealth Silica Company, Chicago, Ill., has been incorporated with a capital of $1,500,000 to mine for silica, lime and other substances. The incorporators are P. Zak, L. L. and B. F. Cowan, Chicago.

Nitro-Phospho Corporation.

To manufacture chemicals and their by-products, the Nitro-Phospho Corporation of New York has been incorporated at Newark, N. J., with a capital of $125,000. George R. Swain, C. Jacobs and J. I. Sipp, Newark, are the incorporators.

$2,500,000 Chemical Corporation.

The Natural Chemical Products Corporation has been incorporated under the laws of New York with a capital of $2,500,000 to manufacture chemicals and chemical products. The incorporators are S. B. Howard, L. H. Gunther and Joseph Curtin, New York.

N. J. Chemical Works Incorporated.

At Belleville, N. J., the Lloyd Chemical Works, Inc., has been incorporated to manufacture chemicals, dyes and allied products. The capital is $20,000 and the incorporators are M. and A. Vandeweghe and Ellis Lloyd, Belleville.

Lamie Chemical Company.

The recently incorporated Lamie Chemical Company, Huntington, W. Va., will undertake the manufacture of chemicals and allied products. The capital of the company is $50,000, and the incorporators are R. D. Lamie, Huntington; A. T. Roberts, Marquette, Mich.; H. W. Shelton, Negaunee, Mich.; John Garvin, Ontonagon, Mich., and Dan H. Ball, Marquette, Mich.

THE CHEMICAL ENGINEER

VOL. XXVI. DECEMBER 1917 No. 2

Published Monthly by the

McCready Publishing Company.

ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, DECEMBER, 1917

American Color Manufacturers to Meet in New York 42

Coal-Tar Chemistry Section.
Conducted by Thomas H. Norton, Ph.D., Sc.D.
Under which is included

EDITORIAL COMMENT:

The Wrecking of Halifax by Trinitro-Toluene 45
A Census of Coal-Tar Products............ 45
A New Use for Naphthalene.............. 46
The Outlook in the United States for Technical Synthetic Chemistry................ 46
"Everyman's Chemistry"................. 49
A French Society of Chemical Industry..... 49
Government Aid to Chemical Research..... 50
Toluene from Illuminating Gas............ 51
The American Supply of Coal-Tar Crudes in the Future........................... 51
Wages in the German Chemical Industry.... 52

INTERMEDIATES:

The Inspection and Testing of Trinitro-Toluene 52
By K. K. Stevens.

ARTIFICIAL COLORS:

Artificial Colors Used in the United States.. 55
By H. Walford Martin.
Exportation of Domestic Aniline Colors..... 61

CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS:

Crudes, Intermediates and Explosives, Synthetic Medicinals, Flavors and Perfumes, Photographic Developers, Artificial Colors. 62
Natural Dyestuffs, Dyewoods and Raw Materials, Extracts, Dyeing Accessories...... 63
British Exports of Dyestuffs.............. 64
Chemical Investigation, Efficiency and Control... 65
Conducted by Charles B. Davis.
Ultra Violet Light: Its Application in Chemical Arts, Part IX........................... 66
By Carleton Ellis and A. A. Wells.
New Publications of the Bureau of Mines....... 73
Aetna Explosives Co. Has Disastrous Explosion. 73
U. S. Bureau of Chemistry Wants Men......... 73
Secretary Lane Names Six Chemists to Serve on New War Board........................... 73
Bureau of Mines to Enforce New Explosives Law 73

New Apparatus:

Specific Gravity Apparatus for Diamonds and Precious Stones.
A New Safety Crystal Which Cracks But Does Not Break....................... 75
Conducted by F. W. S.
Government Paper on Specifications for Motor Gasoline 76
Foreign Trade Opportunities................. 77
Distillates: News Notes of Chemical and Allied Industries 78
New Bureau of Mines Study on the Coking of Illinois Coals........................... 79
December Prices of Chemicals................ 80

AMERICAN DYE MANUFACTURERS TO MEET IN NEW YORK

Not Since Great Britain Upheld Her Title of "Mistress of the Seas" and Proclaimed the Ocean Lanes "Verboten" to German Trading and Merchant Ships, Has the American Dye Industry Received So Powerful a Single Stimulus as the Approaching Conference of Color Makers Is Expected to Produce. Details of the Prospective Event, Together with Some of the Looked-for Benefits, Are Given in the Article Below.

American industrial history will be made at the meeting of dyestuff manufacturers and merchants to be held Tuesday and (if necessary) Wednesday, January 22 and 23, in Rumford Hall, The Chemists' Club Building, 50 East 41st street, New York. In fact, it is not too much to say that the prospective gathering gives every indication of becoming an event which those connected with the color industry will "date time from."

Although he persistently refuses to admit that his role has been anything more than that of a mere secretary, the man chiefly responsible for definite action leading to the coming conference is Mr. G. Gardner McKerrow, of New York. Be that as it may, it was he who many months ago saw clearly the benefits to be derived from a free interchange of ideas between those actively engaged in the manufacture of American dyestuffs; it was he who publicly called attention, through the press and from the platform, to the desirability of such a move; it was he who early interested and enlisted the sympathies of many important factors in the industry, and, when what was deemed the opportune moment had arrived, it was he whom they requested to sound the trade at large as to their feelings regarding a meeting.

Purpose of the Meeting.

The primary object of the gathering, at which some 200 color firms have already signified their intention of being represented, will be the creation of an organization which will enable the American manufacturers to complete their intrenchments against foreign competition, and to so coordinate the industry that when the present great military struggle is over, and the inevitable commercial struggle has begun, they shall not be deprived piecemeal of the fruits of the magnificent effort which they have made to create an independent American dye industry.

Just how it is proposed to accomplish this result, and the necessity for a general meeting in order to bring it about, is best indicated in the two letters sent out to the trade by Mr. McKerrow. The first of these follows:

"I have been requested by a number of gentlemen interested in the manufacture of American dyestuffs, to take the initial step looking to the convening of a Conference at which the question of the standardization of American colors can be discussed.

"I feel that there are others in the industry who have been identified with it for so much longer than I have that some one of these could more properly take this preliminary step, but in order to bring the matter to an issue and to give the industry as a whole a chance to meet and discuss this important and vital question I have decided to act upon the requests that have been made.

"May I suggest that a meeting be held, preferably in New York, as being the most available centre for all interests, during the week of January 21st, 1918?

"I should be pleased to hear from you as to whether this is in accordance with your ideas, and if so, whether this time will be as suitable to you as any other. Upon hearing from all those interested, or as many of them as care to reply, definite steps will be taken to organize this meeting."

Color Men Enthusiastic.

This letter brought forth an exceedingly gratifying response from a large number of concerns, which were quick to grasp the possibilities and viewed the project with notable optimism. So readily did the recipients take to the idea that Mr. McKerrow proceeded with arrangements, and shortly afterward the following letter, explaining further the object of the meeting, was sent out:

"Arrangements have been definitely made to hold the conference for the consideration of the best means for standardizing American dyestuffs, at which you have kindly agreed to be represented, on January 22nd, and if necessary, January 23d next, in Rumford Hall, The Chemists' Club, 50 East 41st street, New York City

"It is hoped that at this conference, at which about two hundred of the leading manufacturers of and dealers in intermediates and dyestuffs have expressed their intention of being present, a consolidation of the new industry may be effected, resulting in the formation of a National trade association, which shall have the interests of the industry permanently in its care, and which shall be representative of the dyestuff trade as a whole.

"No preliminary organization has been attempted and the ultimate developments will be entirely in the hands of those present at the conference. It is hoped, however, that gentlemen present will be prepared to make suggestions; to discuss questions affecting the industry, such as the tariff, arbitration of disputes, etc., as well as the question of the standardization of colors, and that a full and free interchange of ideas looking to the permanent intrenching of the industry may be obtained.

"A note of the final arrangements will be mailed to you about January 15th."

Some of the Expected Benefits.

The movement has been initiated for the purpose of effecting some authoritative method of standardizing American colors, and it is hoped that the conference will result in the formation of such an association representing the new dyestuff industry and which will be effective in protecting the interests of this industry, not only as regards standardization, but questions of arbitration, tariff, protection of contracts, etc.

If the plan is properly worked out, with all its ramifications, it will most certainly sound the commercial death-knell of the dishonest dye manufacturer and the unscrupuious broker. These two types of individual have done quite as much as any German propagandist in the way of discrediting the American dye industry in the eyes of the general public. But the activities of such undesirable citizens can be effectually eliminated, for, as Mr. McKerrow declares, "short of police or military force, which, of course, would hardly be available for this purpose, the best way to make a man live up to an ideal is to make it worth his while to do so," and this is one of the things which it is proposed to accomplish.

How Dye Standards May Be Regulated.

The initial idea regarding standardization is designed to overcome the difficulty under which the new industry is now working, in that every maker, if he has any standard at all, has his own, and this bears no relation either as regards the tinctorial value of the colors offered or the price, to the products of other manufacturers. The need of definite trade standards against which all colors may be tested as they are produced is not only urgently needed by the dyestuff manufacturing industry itself, but by the consumers in the color using industries, and is further also urgently required by the Government in its consideration of questions of tariff as bearing upon the dyestuff industry.

Government Will Be Represented.

The Government is to have representatives present at the conference, and these officials will undoubtedly give expression to the desires of the Government in this regard.

It is also hoped that the conference may result in the establishing of a board of arbitration, which will necessarily operate in parallel lines with the question of standardization in that the great majority of disputes which arise are as to whether deliveries have been equal to samples submitted. This difficulty has already been productive of an enormous number of lawsuits which entail endless delay and expense and which could properly be quickly and finally adjudicated by a mutual reference of the difficulties to an impartial board of arbitration supported by the authority of the trade organization and passing upon the merits of the case through the laboratory which will be established by the organization.

H. Gardner McKerrow.

"Let's Go!"

As one of the organs representing the industry, the CHEMICAL ENGINEER believes that it would be difficult to exaggerate the importance of this meeting, not only to the industry as a whole, but to the individual members of the National Association which it is to be hoped will result. And because of its earnest desire to render any service possible to those engaged in advancing the interests of the American dye industry, this publication further desires to emphasize its belief that the proposed conference will be highly beneficial in its results, to congratulate those who have decided to be represented, and to urge upon all others a further and careful consideration of the project.

Any individual or firm desiring additional information can obtain it by addressing Mr. McKerrow, in care of E. F. Drew & Company, Inc., 50 Broad street, New York City.

Some of the Elect.

Below follows a list of the firms which, up to the time when this issue went to press, had signified their intention of being represented at the conference:

A & B Export & Import Corp., 78 Wall Street, N. Y.
Ackerman Co., Inc., H. R., New York.
Agawam Chemical Works, Providence, R. I.
Althouse Chemical Co., Reading, Pa.
American Color & Manufacturing Co., Passaic, N. J.
Atlantic Dyestuff Co., Boston.
Atteaux & Co., F. E., Boston.
Ault & Wiborg Co., Cincinnati, Ohio.
Bayer Co., Inc., 117 Hudson street, New York.
Barrett & Co., M. L., Chicago, Ill.
Bick & Undy, Philadelphia, Pa.
Binney & Smith Co., New York.
Bird & Co., J. A. & W., Boston.
Bloede Co., Victor G., Baltimore.
Bosson & Lane, Atlantic, Mass.
Boston Dyewood & Color Co., 136 Federal St., Boston.
Bothamley & Co., 309 Broadway, New York.
Bowring & Co., 17 Battery Place, New York.
Cabot, Inc., Samuel, Boston.
Cambria Steel Co., Philadelphia, Pa.
Century Color Corp., 182 Front street, New York.
Chemical Co. of America, New York.
Commonwealth Color & Chemical Co., Brooklyn, N. Y.
Commonwealth Color & Chemical Co., Philadelphia.
Cosmic Aniline Works, Inc., New York.
Cronkhite Co., Boston.
Cullin, A. R., 104 S. Adams avenue, Margate, N. J.
Dana & Company, Inc., 111 Broadway, New York.
Delta Chemical Co., Inc., 11 Warren street, New York.
Dicks, David & Broadfoot, Inc., 302 Broadway, N. Y.
Dow Chemical Co., Midland, Mich.
Dunker & Perkins, Boston.
Dye Products & Chemical Co., Inc., New York.
Federal Dyestuffs & Chemical Corp., New York.
Fieldhouse, W. H., 176 Federal street, Boston.
Fine Colors Co., Paterson, N. J.
Fisher Chemical Co., 170 Summer street, Boston.
Ford Co., J. B., Wyandotte, Mich.
Fortner Co., L. B., 36 Strawberry street, Philadelphia
Fuerst Bros. & Co., New York.
Georgia Ochre Co., 165 Broadway, New York.
Gessler, Dudley D., Philadelphia.
Hadjopoulos & Sperco, Inc., 29 Broadway, New York.
Hartley, Frank, 146 Summer street, Boston.
Haight & Co., Samuel, 66 Batterymarch street, Boston.
Hellenic Chemical & Color Co., Inc., New York.
Heller & Co., B., Calumet ave., & 40th St., Chicago, Ill.
Heller & Merz Co., H. A., Newark, N. J.
Herman & Herman, Inc, New York.
Hine Bros., 80 Maiden Lane, New York.
Holland Aniline Co., Holland, Mich.
Holliday-Kemp Co., New York.
Hord Color Products Co., Sandusky, Ohio.
Huisking, Chas. L., New York.
Imex Corp., 25 Beaver street, New York.
Imperial Car Cleaner Co., 115 Chestnut St., Newark, N. J.
Innis, Speiden & Co., New York.
Iridescent Dyestuff Color Co., 251 Bush St., Brooklyn.
Jacksonville Chemical Mfg. Co., Jacksonville, Florida.
Jaeck Co., Louis, New York.
Jennings & Co., 93 Broad street, New York.
Jorgensen Co., Chas. A., 55 Franklin street, New York.
Katzenbach & Bullock Co., New York.
Kley, E., 40 Pine street, New York.
Klipstein & Sons Co., E. C., 644 Greenwich St., N. Y.
Kretschmar, A. W., 396 Broadway, New York.
Kuttroff, Pickhardt & Co., Inc., 128 Duane St., N. Y.
Lewis, John D., Providence, R. I.
Linburg, J. F., 101 Beekman street, New York.
Lyon, Julian W., 101 Beekman street, New York.
MacAndrews & Forbes Co., New York.
MacEvoy, Thos. J., 1126 Ontario street, Philadelphia.
Madero Bros., Inc., New York.
Manhattan Color and Chemical Co., New York.
Manhattan Trading Corp., 2 Rector street, New York.
Marden, Orth & Hastings Corp., New York.
Martin Co., The L., New York.
May & Co., Inc., Frank L., New York.
Middlesex Aniline Co., Inc., New York.
Monroe Color and Chemical Co., Quincy, Ill.
Monsanto Chemical Works, St. Louis, Mo.
Morrill, George H., Norwood, Mass.
Morris Co., F. Ellis, Drexel Bldg., Philadelphia.
Mount Union Tanning & Extracts Co., Mount Union, Pa.
National Aniline and Chemical Co., Inc., New York.
Newport Chemical Works, Inc., New York.
Oakes Mfg. Co., Long Island City, N. Y.
Obex Co., Marietta, Ohio.
Organic Products Corp., Schenectady, N. Y.
Osborn Co., C. J., 132 Nassau street, New York.
Parsell & Co., C. C., Chicago, Ill.
Peerless Color Co., Bound Brook, N. J.
Ph. Van Ommeren Corp., 42 Broadway, New York.
Read Holliday & Sons., Ltd., New York.
Reliance Aniline & Chemical Works, 100 Broadway, New York.
Rutherford & Co., J. G., 505 Broome street, New York
Seydel Manufacturing Co., Jersey City, N. J.
Sherman & Mason, 211 N. Front street, Philadelphia
Sherwin-Williams Co., Cleveland, O.
Sloan & Russell, 132 Nassau street, New York.
Stanley Aniline Chemical Works, Lock Haven, Pa
Tower Chemical Co., Inc., 253 Broadway, New York.
U. S. Dye Extracts Co., Inc., 801 Vernon avenue, Long Island City, N. Y.
United Supply Co., 826 Lafayette Bldg., Philadelphia
Waldo, E. M. & F., New York.
Western Aniline Products Co., Chicago, Ill.
White, Inc., John J., 149 Broadway, New York.
Williamsburg Chemical Co., Inc., Brooklyn, N. Y.
Wood, Inc., J. Early, 21 Platt street, New York.
Young Co., Frank L., Boston.

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors.
Synthetic Medicinals, Flavors and Perfumes. Explosives,
Photographic Developers.

Edited by
THOMAS H. NORTON, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

George H. Bruce, LL.B., Keystone Fibre Products Co., Inc., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hebden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles.

H. Gardner McKerrow, of E. F. Drew & Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

EDITORIALS

The Wrecking of Halifax by Trinitro-Toluene.

In none of the battles of the great war have high explosives caused such loss of life and such destruction of the results of human effort as happened in the terrible disaster which visited the city of Halifax on December 7. Through an accidental collision fire was started on a steamer laden with trinitro-toluene, making a brief stop in the harbor on its way to France. The quickly following explosion, brought about a loss of life going into the thousands, with greater numbers of seriously injured, while over 25,000 persons were suddenly rendered homeless. The destruction was so sudden, so widespread, that the disaster will rank historically with such earthquakes as those of Lisbon, San Francisco or Messina, or with the tragedies following great tidal waves or floods.

The material loss exceeds $25,000,000. Needless to say, the sympathies of the entire continent have gone out to the unhappy Nova Scotian city, and relief has streamed from every quarter.

There is a warning to us to be more closely upon our guard, in connection with the movements of all vessels transporting high explosives. It would appear that the ill-fated steamer in question carried also a large consignment of benzene as a deck cargo. This latter was first ignited and the impossibility of extinguishing this conflagration led to the fatal explosion.

Rigid regulations with regard to the character of freight carried upon a vessel conveying explosives should be established. Equally rigid regulations should control every movement of such a vessel when in or near a port.

Nowhere are such protective measures more needed than at the port of New York. The effect upon the skyscrapers of the city of an explosion of T.N.T., even at a distance of several miles, can easily be imagined.

Thus far there have been numerous serious and costly explosions in the factories where high explosives are manufactured. The tragedy at Halifax is the first to occur in connection with the transportation by water of the deadly material.

A Census of Coal Tar Products.

One of the first duties of the United States Tariff Commission is to provide for an exhaustive census of coal-tar products.

In the revenue act of September 8, 1916, special provisions were made to give additional tariff protection to coal-tar products. Coal-tar crudes continued on the free list. Coal-tar intermediates, however, are subject to an import duty of 15 per cent. *ad valorem,* plus a specific duty of 2½ cents per pound. Coal-tar colors, medicinals, flavors, perfumes, photographic developers, etc., pay an import duty of 30 per cent. *ad valorem.* In addition there is a specific duty of 5 cents per pound on all colors except anthracene dyes, indigo and the indigoids. At the expiration of 5 years (in 1921) these specific duties are to be diminished by 20 per cent. each year and disappear entirely in 1926. If, however, in 1921, it shall not be evident that the country is producing at least 60 per cent. of its consumption of the articles in question, then the specific duties shall be abolished at once.

It becomes the duty of the Tariff Commission to secure the needed statistical information for the purpose of deciding the extent of the national production in 1921, and its relation to the entire consumption. The Commission will naturally have the assistance of the Treasury Department in order to establish the amount of foreign importation four years hence, although in this connection uncertainties may arise as to just how much of the importation in a given fiscal year enters actually into consumption. This difficulty may be increased if it happens that 1921 arrives at a period when international exchanges are resumed and stocks generally are being renewed.

The Commission must depend upon its own efforts to establish the amount of the domestic production. It has wisely decided that it must promptly begin its apprenticeship. Accordingly it will make a preliminary enumeration in 1918, enabling it to get into touch with the entire coal-tar chemical industry. These relations will be maintained and presumably the Commission will be able in 1921 to secure promptly and accurately all neded data.

The Commission is undertaking a general survey of our chemical industries, and will present later to Congress important suggestions in connection with desirable changes in classification and rate schedules.

Especially in connection with coal-tar chemicals is there an ample field for improvement. It is still a puzzle to all chemists why synthetic medicinals, flavors, perfumes, etc., as well as anthracene colors, indigo and indigoids, should be excepted from the provisions of the specific duty of 5 cents per pound. It is impossible to present any logical reason why artificial indigo should not have the same protection as Methylene Blue or Victoria Blue. The word "indigoids" is, furthermore ambiguous and likely to lead to litigation. It is, also, not clear whether explosives are to be included under the classification of finished coal-tar products. All of these uncertainties should be promptly cleared up by clean-cut, accurate, logical legislation.

The Commission is issuing a circular letter of inquiry to all firms engaged in the manufacture of coal-tar chemical products, which will enable it to secure exact information as to the extent of the industry at present, and the amounts of the different chemicals now produced.

The ground work for this has already been laid by the extensive studies in this field carried on by the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

A New Use for Naphthalene.

Under the stimulus of an increasing lack of many chemical products, hitherto regarded as essentials, German inventive genius is actively at work devising numerous substitutes. One of the latest results is to transform naphthalene into an oil which can be used for illuminating purposes, very much as petroleum. The reaction is effected by heat, under pressure, in the presence of aluminum chloride. Details on the operation are lacking. It may possibly open up a general method for the more abundant utilization of naphthalene than has hitherto been the case.

The Outlook in the United States for Technical Synthetic Chemistry.

There is a rapidly growing conviction that this country will become absolutely independent of foreign sources for its synthetic drugs and dyes, if there is the proper cooperation between governmental action, industrial enterprise and our institutions of higher scientific training. We can not attain and maintain such a position unless our facilities for research are brought up to the proper standard and a numerous corps of our younger chemists are attracted to the field of organic investigation. That this latter condition of success is well assured would appear to be the case as we analyse the current output of valuable memoirs issuing from American chemical laboratories, and devoted to problems in organic synthetic chemistry. Not a few American universities are becoming active centers of organic research and contributing results fully comparable in extent, as well as in technical and scientific value, to those of many German institutions.

Analogous conditions exist in several of the more powerful companies devoted to the manufacture of chemical products. During the past few years the scientific staffs of these organizations have been notably increased and the field of research broadened.

The general topic was admirably treated by Professor Julius Steiglitz in his address, as President of the American Chemical Society, at its September meeting in Boston. From this address the following pertinent passages are quoted:

"Much more than a question of coloring materials is concerned in a conscious policy to have our dye industries established on a permanent basis. It has often been emphasized that the manufacture of dyes is so closely related to the preparation of explosives that a flourishing dye industry in times of peace means ample facilities for explosives in times of war. No American would care to contemplate what our position would be in the matter of large scale production of explosives if we had become engaged in a struggle with a first-class power without the benefit of the great expansion in our dye and explosives factories which our commerce with England and France brought about after 1914! When peace comes, let no American forget this lesson! One way of insuring ourselves against a lack of facilities for a sudden expansion in the production of explosives is to keep capital invested in dye factories.

"Independence in the preparation of medicinal remedies, especially also of the finer modern products which we call synthetic drugs, should be as conscious an aim of the United States as independence in the manufacture of dyes. It is worth noting that the two aims support each other, for nearly all of the basic products needed for the large-scale preparation of synthetic remedies are either prepared in aniline dye factories, as intermediate steps toward dyes or are so closely related to such compounds that it would be a mere detail to include these products in the normal output of a dye factory. As an instance pointing in this direction, recent correspondence with a prominent American firm, which has invented and is manufacturing what promises to be a valuable substitute for cocaine in producing local anesthesia, brought out the fact that the chief difficulty in the way of production of the drug on the large scale which the situation demands, lies in the securing of sufficient quantities of the chemicals diethylaniline and cinnamic acid. Now, the former could and should be manufactured in dye factories with the greatest of ease, side by side with dimethyaniline, which is a common intermediate in the manufacture of many dyes, and cinnamic acid could be prepared from benzaldehyde, another intermediate. Furthermore, large research departments in well-organized dye factories will be centers of research in applied organic chemistry and practically all of our valuable synthetic drugs are such organic compounds. Indeed, it will be a matter of time only—and I should like to see that time shortened as much as possible—when some of our best-equipped and most progressive dye factories will turn to the problem of these remedies as a question of the economic utilization of their equipment. That has been the history abroad and it will be the same here. In fact, together with our long-established great pharmaceutical houses, they should find even richer, unexploited fields of effort in the problems of synthetic drugs than in those of dyes. Without question the average man spends on necessary drugs for his family at least a thousandfold the value of the dyes in the wardrobes of his whole family—the ladies, of course, included. The twitchings of rheumatism or gout, sleepless nights or a cantankerous cold are most urgent and persuasive drawers on a family purse. My professional friends know well how the modern dye industry has been built up on an accurate scientific knowledge of the connection between color and what we call the structure of the molecules, those minute worlds on the knowledge of which our power to reconstruct matter rests. We know, too, that the dye industry has reached, or almost reached, its full maturity and capacity. But we are only on the threshold of exactly the same kind of development in the discovery of improved remedies for curing human ills because the connection between the structure of our molecular worlds and their medicinal effect is just beginning to be systematically elaborated. Great industrial establishments founded on organic chemistry, like the dye manufacturing and the great pharmaceutical houses, collaborating with research laboratories in universities and in medical institutions, would hold out to this country the promise of a share in realizing a duplication of the conquest of the world of color, which has occurred in the last fifty years, by the greater conquest of the world of scientific medicine! A brilliant beginning has been made in this campaign by the preparation of excellent substitutes for cocaine, less toxic than cocaine itself—by the elaboration of salvarsan, by the isolation in our own country, and the artificial production, of adrenalin, a vital regulating principle produced by an organ, the suprarenal capsule, in our bodies. The isolation and exhaustive study by Kendall of the active principle of the thyroid gland, which no doubt will be followed by its artificial preparation, is a second brilliant instance of American success in this great field! When we consider the countless number of animal preparations—gland extracts, serums, and antitoxins—the pure active principles of which are all we really want, but which are injected into us or fed to us, with an extraordinary amount of unnecessary and often harmful animal matter, we can realize what a boon to humanity this line of effort really means. Let me emphasize again, it is chiefly a matter of wise and foresighted legislation to make our independence and possibly our leadership in this great field possible—we have proved that we have the scientific ability—it is a question only of putting this work on the basis of an established industry!"

* * *

"Now, thoughtful men in our society, looking ahead, see that this great uplift in our scientific life is facing dangers which, unless they are met frankly and effectively, will bring on a period of depression which will be a grave menace to all the varied fundamental interests in the life of the nation that depend on chemistry.

"The first and greatest of these menacing developments has its root in the recent unprecedented demand of our industries on our schools for research men. From university after university, from college after college, the combined lure of great research opportunities and of much larger financial returns has taken from our academic life far too many of our most promising young men, the very men on whom the country has been depending for the filling of our great university chairs as the older men now holding them gradually will age and retire. Unless prompt measures are taken we shall witness in a few years such a dearth of first-class tried material for professorships that second-rate men will be placed where the national welfare needs the best we have, and third and fourth-rate men will be occupying positions in which we should have young men of the highest promise in the period in which they are reaching full maturity. Indeed, it is greatly to be feared that even now we are witnessing gradual lowering of standards. It would be futile to appeal to our industries not to call the men they need, although in the not distant future they will suffer most severely from the situation which is developing, if the present tendencies remain unchecked. The only possible source of relief lies, I believe, with the presidents and trustees of our great universities and to these the second main plea of this privileged discussion is addressed. These authorities should recognize the fact that their institutions have now entered a period of severe competition between the industries and academic life for chemists of the highest type and greatest promise. They have already learned the only method of meeting this kind of competition successfully, for they have faced the same problem in two other professions, medicine and law. In the face of the tremendous financial attractions of the practice of either of these professions our most progressive universities have simply put their law and their medical faculties on a higher, more nearly professional scale of endownment of professorships than obtains for other faculties. They must, it seems to me, take the same measures with their chemistry staffs; it is primarily a question whether they can be awakened to that need now or whether they will let the country suffer from their lack of foresight and let us learn from the most efficient of our teachers, bitter experience. Wise provision now would not only safeguard our present standing in a critical period of our history, but in this time when the importance of chemistry has been brought home to our young men as never before, the new attitude, properly announced, would attract a larger proportion of the men of brains, talent and ambition, who enter professional life but tend to study law or medicine as holding out much greater opportunities for satisfying their ambitions.

"Adequate compensation is important for a research man—and to his type in university and college I must restrict my remarks—it is important both from the point of view of his self-respect and also especially for the sake of comparative freedom from worry concerning a fair provision for his family. But inadequate compensation is not the only danger seriously threatening the outlook for chemistry in our universities. Let us remember that healthy progress in our science is dependent primarily on university men pursuing great lines of original investigation. It is true that we have now well-endowed national institutions of research, such as the Rockefeller Institute and the Carnegie Institution, but universities cannot afford to surrender to these the main burden of insuring progress in the theory of our science, because these are not teaching institutions. To take from our universities the choicest of our research men would deprive our young men of that inspiration and fertilization of their minds in the period of their greatest acceptiveness, which early intimate association with great investigators alone can give. To my mind it is clear that if universities would fulfill their highest mission they must remain the seats of the best type of research."

* * *

"I have dwelt on the details of this great problem which is confronting our society, because I would protect the outlook for the growth and success of theoretical chemistry in our country by every means in my power. We have a splendid record; we are easily leaders in the domain of knowledge based on the exact determinations of atomic weights—a knowledge which leads among other results to habits of more exact, more critical methods in all fields of our science. Arrhenius told us that America is leading in the difficult work of the rigorous examination of the theory of ionization and of establishing it on a finished basis. The development in the field of free energy relations is more intensely cultivated here, I imagine, than in any other country. In the application of modern theories of atomic structure and of the electron theory of valence to all branches of chemistry, especially also to organic chemistry, we are, I believe, easily in the front. Our very youth, as a people, has preserved to us in science as in national sentiment, that whole-hearted enthusiasm for ideals, which in world politics has made us the most altrustic nation on the face of the earth and which in science finds its expression in the pursuit of knowledge for the sake of the pure truth alone, a pursuit characteristic of the best research in our universities and colleges!

"And so let me conclude my remarks on the outlook for chemistry in America by emphasizing that we have a goodly heritage of success both in our great industries and in our great universities, which will form the safe basis of a brilliant future, if we will but approach the problems of the moment and of the immediate future in characteristically American fashion with a spirit wisely combining altruistic principles with practical, worldly common sense. This means the "square deal" in industrial life for the product of the brains of the research chemist, combined with wise laws to insure to capital a fair and tolerably safe return for investment in chemical industries, needed to make our country chemically independent. And it means too the placing of chemistry in our universities on a plane with the other great professions, law and medicine, in order to hold in this great science, so important for the welfare of the nation, the needed numbers of men of brilliant minds and energetic ambitions—combined with the devotion on their part to the search for the truth, to the establishment of the great laws of our science, for the sake of that truth, that science alone."

"Everyman's Chemistry."

THE CHEMIST'S POINT OF VIEW AND HIS PRESENT WORK,

By Ellwood Hendrick.

Harper & Brothers, 1917. Pp. 374. Price, $2.00.

There are scores and scores of "popular chemistries" in various languages, in which the emphasis rests sometimes upon the noun and sometimes upon the adjective.

It is not often that the well-equipped scientist possesses the happy gift of visualizing fact and theory from the standpoint of the man in the street. The ability is possessed by the French more generally than by other nations. It is difficult for Frenchmen, even when dealing with exceptionally abstruse matters, to be otherwise than clear and interesting. Liebig, among German chemists, possessed the faculty in a high degree, and it was one secret of his marvelous influence upon the development of his science. Geoffrey Martin, in Great Britain, has done excellent work in popularizing chemistry. Many Americans are indebted to the works of Youmans half a century ago, or the more recent volumes of Sadtler, and especially of the late Robert Kennedy Duncan, for inspiring guidance into the mysteries of chemical science.

In the present book we encounter practically a novelty in chemical literature. It is not only replete with fact, well arranged and lucidly presented, above all accurately stated, and has sufficient theory outlined in an easily understandable manner; but the element of human interest is constantly in the foreground and the book bubbles over with humor.

There is scarcely a page which does not evoke a smile upon the face of the reader, whether he be a Ph.D. of many years standing or a novice gleaning his first ideas of what chemistry means. Quaint allusions, novel descriptions, vivid similes, dramatic comparisons, all combine to render the work as fascinating as a romance, while impressing its contents firmly upon the memory.

A striking head for a chapter is "The Redheaded Halogens." It is quite understandable from the remark "We are wont to attribute to men and women having auburn hair a certain quickness in response to a stimulus."

Imagination and memory both are aided by such epigrams as: "Fluorine is the young devil, iodine is the old man with a past"; "Tin is one of the very trickiest of metals"; "$CaCl_2$ is one of those chemicals that is still looking for a job"; "Atoms are given to polygamy and polygandry as matters of entire propriety, and if it were not for the fact that we cannot imagine atoms as having sex, the way they shift about in their matings would scandalize any community"; "The benzol ring is as whimsical as an Irish lass"; "The isonitriles smell to high heaven"; "The (adjective deleted by publisher) stuff known as cocoa powder is the pulp of the cocoa beans with nearly all the oil pressed out"; "You can't pick mercury up, and that is a good way to prove that it is a liquid"; "When you come right down to it, some metals are no better than nitrogen in the way of being plain-spoken and easily understood"; "Iron is not found in the pure state because in time the oxygen will get it—whether it watches out or not."

With all this whimsicality and colloquial familiarity the book is well-balanced, carefully arranged and eminently adapted to meet the needs of a multitude of busy people, desirous of gaining an intelligent acquaintance with the mass of chemical phenomena in the midst of which our life is passed. The number of these increases rapidly as the world realizes to an increasing extent how largely the titanic conflict, now raging, is a war of chemists.

Mr. Hendrick terms his book a ramble through "that branch of philosophy and poetry which has to do with the Ways of Stuff," and it is a correct characterization. He has succeeded admirably in producing a scientific manual which is brimful of human interest.

The work is without illustrations. It is a question, in these days, whether the full value of a popular treatise on chemistry is secured without an ample appeal to the eye. T. H. N.

A French Society of Chemical Industry.

The British Society of Chemical Industry has become a powerful agency for the development of technical chemistry in the British Empire, and even throughout the world. It has strong sections in this country as well as in the British colonies. The organization has worked harmoniously, side by side with "The Chemical Society" of London, devoted more exclusively to the interests of pure chemistry, and the oldest of our chemical societies.

France has had for many years a society similar in aims to the last mentioned, "Société chimique de France," (formerly the "Société chimique de Paris"), which has been of the greatest value in furthering the interests of the science in the French Republic.

Recently, French technical chemists felt that the time was ripe for organizing a separate body devoted to applied chemistry, more especially in connection with the strenuous efforts now made to render their country entirely independent of German sources of chemicals. They have accordingly established the "Société de Chimie Industrielle," with headquarters at Paris, 49 rue des Mathurins. The president is M. Paul Kestner and the secretary M. René Engel. It is interesting to note in the case of the above, as well as of several other officers of the society, the presence of Alsatian names. Beginning with Adolph Wurtz, Alsace has contributed for the past half century an exceptionally large number of gifted chemists to France.

The secretary of the new society, M. Engel, was a member of the French Scientific Mission to the United States. A number of leading American chemists, after conference with him, have felt that it would be most opportune to organize an American section of the French society, and that in this way we might do much to strengthen the efforts of French colleagues at a moment when support, moral and financial, would be of the greatest assistance.

Over thirty chemists form the nucleus of the new American section and their number is steadily increasing. The Organization Committee has headquarters at the Chemists' Club, 50 E. 41st St., New York City, and furnishes full information to all inquirers.

There is no doubt but that a strong section will be formed, and it will do much to establish closer ties between the chemists of the two republics. The happiest results have followed the existence in this country of sections of the corresponding British society.

Government Aid to Chemical Research.

There is a strong feeling in this country that much might be done to further the rapid growth and expansion of the artificial color industry by highly organized research on the part of governmental agencies. To some extent this feeling has been reflected in the legislation of the past two years, in which provision has been made, on a somewhat modest basis it is true, for investigations in this field by the Bureau of Chemistry in the Department of Agricultural.

In this connection it is interesting to note the attitude toward the question taken by the British "Commitee for Scientific and Industrial Research," organized by the Privy Council.

Much of the activity of the committee has been directed to stimulating cooperative research in various industrial branches. This has not been easy, for the traditions of British industrial development are firmly based upon pronounced individualism.

In the committee's report for the fiscal year 1916-1917 the position of the leading chemical industries is submitted to a careful analysis, and the following conclusions are drawn:

"We have remarked that those industries which call for the most complex organization, and are most in need of scientific guidance, if they are to meet modern conditions sucessfully, are, for the most part, those in which the smallest progress has been made towards research on a cooperative basis. We refer to that large group of what may be called the chemical industries. At the one end of this group we find a growing movement towards financial combination—e. g., among the highly developed heavy chemical and allied industries. Financial combines or fusions of scientific industries on the scale we are witnessing will certainly render cooperation for research alone less attractive, if not unnecessary. At the other end of the scale are industries, like those of pottery and glass, which have been driven by adversity to seek the aid of science, and have only been able to meet the cost by operating together. Between the two extremes is a large number of industries, some of them wealthy, which appear to be uncertain in which direction to move, and would probably prefer to move in neither.

"The German chemical industry, with its powerful firms engaged in handling the primary raw materials through all their intermediate stages up to the manifold but closely related final products—explosives, dyes, essences, drugs, antiseptics—would not be suited for cooperative research, though it may be prepared to go far in the direction of financial fusion—a mere continuation of the previous line of development. If, as in this country, conditions are in many respects specially favorable to cooperation in the conduct of research, the State is, we think, justified in encouraging development along these lines by means of monetary and other assistance."

The ideas formulated by the committee are especially applicable to this country. Even more than in Great Britain, we need the powerful assistance which can be given our coal-tar chemical industry by a highly perfected scheme of research involving the close cooperation of the different units concerned as well as of governmental agencies. Time is an all-important factor. The industry must be rounded out as rapidly as possible while the exceptional opportunity is afforded of freedom from competition.

It is hardly correct to state that the German chemical industry, and more particularly the German color industry, is not suited for cooperative research. Undoubtedly much has resulted from the well organized research laboratories of the few big companies. The general progress has, however, resulted from the effective cooperation of the expert staffs in the chemical laboratories of the universities and schools of technology—all highly subsidized by government appropriations. These have served as clearing houses, so to say, of the results of individual inititative. They have focussed scientific and technical attention upon the great possibilities attendant upon newly developed classes of reactions. They have supplied a vast mass of closely related scientific fact and theory absolutely essential for swift progress along economic lines.

In a very real sense there has been close and effective cooperation between the scientific agencies of the different German States and the various factors of the coal-tar chemical industry. The relations of the latter to means of military power have intensified the connection.

The same may be said for conditions existing in Switzerland, where the situation of the color industry is relatively so strong.

One feature of cooperation, formulated by the British Committee, is eminently practical, and could well be imitated by any similar organization in this country when dealing with industries which have failed to appreciate the importance of chemical control and assistance.

The Committe is prepared to attach a young research worker to the works laboratory of an industrial plant for an agreed length of time, divided into three periods. During the first period the Committee would pay the salary of the worker, during the second the Committee would pay half, and during the third the firm would pay the whole.

Full details of this scheme remain to be elaborated. It would appear, however, to be a very practical method of demonstrating to the management of a plant the financial value of expert chemical assistance.

During the past year the British Committee has expended $70,000 and has rendered aid to forty-four different industrial researches.

Toluene from Illuminating Gas.

The question of removing benzene and toluene from the illuminating gas of our cities, for the purpose of isolating therefrom the toluene and placing this at the service of the munition makers, is now being pushed actively.

The War Department claims that it will need at least 300,000,000 pounds of toluene annually to provide the proper amount of high explosives for an army of 1,000,000 men.

The present annual output of toluene from by-product coke oven plants is about 80,000,000 pounds. If all available toluene from American gas works were recovered, the amount would not exceed 150,000,000 pounds. This means that under the most favorable conditions, we cannot secure from the distillation of American coal, as now carried on, more than 230,000,000 pounds of toluene. This is materially below the needs of our own army, not to mention the requirements of the allies.

In order to meet the demands of the War Department, the matter is under active discussion by the gas companies of New York. There seems to be a willing readiness to install the requisite recovery plants. A chief difficulty encountered is the necessity of changing the existing candle-power standard. It is proposed to substitute in its place the present British thermal unit.

The Public Service Commission has started a series of hearings on this subject. In all probability consumers of gas will soon be obliged to content themselves with a product of less luminous power, but nearly equal heating power. In view of the widespread use of incandescent mantles, and of gas for purely heating purposes, this may not be such a serious deprivation.

The American Supply of Coal Tar Grudes in the Future.

There is a steady increase in the number of by-product coke ovens in this country which shows that American metallurgical interests are firmly convinced that the wasteful bee-hive type must disappear at an early date. The amount of coke produced in retort ovens in 1914 was 32.5 per cent of the total quantity. In 1915 it was 33.8 per cent, in 1916, 34.9 per cent. During 1917 it is estimated at 40 per cent.

This means that under normal conditions the American output of coal-tar crudes will be far in excess of any domestic industrial demands. .

In 1914 some 12 by-product coke plants were equipped to recover light oil or crude benzol. The total annual output was less than 7,500,000 gallons. To-day all of the 52 by-product coke plants in the United States, with one exception, are provided with benzol scrubbers. The output of light oil is now about 60,000,000 gals. This yields nearly 10,000,000 gals. of refined toluene.

At present all of this toluene is required for the manufacture of trinitrotoluene, for use as an explosive, and much of the benzene is transformed into picric acid.

When the war demand for these hydrocarbons ceases, the question arises as to the profitable use for the great output. The coal-tar chemical industry of our country is steadily expanding, but for some years it cannot consume in the manufacture of synthetic colors, medicinals and allied compounds, more than about one-tenth of the light oil now available.

The logical result will be to use the large available excess as motor fuel. Benzene alone, or preferably when it contains 10 per cent of toluene to lower its freezing point, is an ideal fuel for motor engines, equal if not superior to gasoline. Benzol recovery plants can be operated with a fair margin of profit on gasoline prices, and the reaction of this additional source of motor fuel on the steady tendency upward of gasoline rates will be generally welcomed.

Of other by-products of the coke ovens, obtained from the tar recovered, there would seem to be no question that all of the phenol recovered can be profitably used, and that there will be an ample market for the creosote oil. But a relatively small quantity of the cresols present in tar oils need to be separated and refined for the needs of color manufacturers.

It is quite a problem how to utilize completely the available naphthalene, which constitutes about 8 per cent of coal-tar, and can readily be isolated from the carbolic and heavy oils. The actual amount needed by color works is considerable, but represents only a fraction of what is available. Prior to the war most of our refined napthalene, for use against moths, was imported. There is now sufficient protection on the article, so that current needs will be covered by the domestic production. These total needs are, however, far from equaling the large quantity available, if there is commercially an inducement to refine it. It is to be hoped that our coal-tar chemists will gradually work out new opportunities for the economic utilization of this abundant hydrocarbon.

Anthracene is present in much less amount and constitutes not over 0.3 per cent of coal-tar. This quantity will, however, amply suffice for the manufacture of all the alizarin, and the various anthracene colors which the American consumption requires and have a large surplus.

There is much to indicate that the activity of chemical research along tinctorial lines will find its best results among anthracene derivatives. Categories of new dyes, allied closely or remotely to the algol, indanthrene and similar colors, may be evolved, which will call for increasingly large amounts of anthracene.

In regard to the coal-tar crudes, called for in relatively small amounts, such as xylene, phenanthrene and carbazole, the supply will be far in excess of any prospective demand, and but a small proportion will need to be isolated and refined. There is little or no attempt made thus far by our American color makers to utilize phenanthrene or carbazole, but at an early state they may be called into requisition. Xylene is now used to some extent and will be used more freely. There will remain, however, a large surplus which can probably be used to a greater or less degree as a motor fuel in connection with benzene.

The chief problem to be solved will apparently be that of the complete and profitable utilization of available naphthalene.

Apart from the use of the coal-tar crudes, there is, also, a certain problem to be worked out in connection with the vast amounts of residual pitch remaining from the distillation of coal-tar. In Europe his has been solved by the extensive manufacture of briquettes from coal waste, using pitch as a binder. There is no reason why this manufacture in the United States should not expand far beyond its present limits.

Wages in the German Chemical Industry.

There has been a steady increase in the rate of wages paid to operatives in all branches of industry in Germany during the war, just as has been the case in other belligerent lands. The average increase, during the first two years of the war, was for males 46 per cent and for females 54 per cent. Strange to say the increase has not been so marked in the chemical industries as in case of machinery, metallurgy and especially electrical branches. The average daily wage of men in the chemical industry rose from 5.14 marks ($1.25) in March, 1914, to 6.90 marks ($1.64) in September, 1916, an increase of 34 per cent. For women the increase was from 2.36 marks ($0.45) to 3.55 marks (($0.71), or 50 per cent. Men engaged in electrical works had an average increase of 65 per cent.

The rise in wages is, however, very far from keeping even step with the increased value of food which costs double the prices of 1914.

COAL-TAR INTERMEDIATES

The Inspection and Testing of Trinitro-Toluene.*

By K. K. Stevens

Trinitro-toluene, although long known to chemists, is comparatively new in the field as a military explosive, and for brevity is designated by various trade names, such as "Trotyl," "Tritol," "Trinol," "Tolite," "Trilit," and commonly known as TNT.

Picric acid or trinitro-phenol was, and is still, used to a large extent as the principal explosive of this class, under the names of "Lyddite" and "Shimose." Picric acid and TNT belong to the "brisant" or shattering class, and are used largely in the manufacture of shells, torpedoes, mines, and, either alone or as components, in detonators or "exploders." The chief disadvantage in the use of picric acid is its tendency to form very sensitive picrates with the metals of shells, etc., and necessitates strict specifications for these materials.

TNT has several advantages over picric acid, viz.:

(1) Inertness towards heavy metals, in direct contrast to the picric acid, although caustic potash or soda form compounds with TNT which will cause it to explode at even 160° C.

(2) Lower fusion temperature, which allows pouring to be done at 81° C. or lower, while picric acid requires a temperature of 115° to 120° C.

(3) Stability in storage; it can be stored indefinitely without change in composition.

(4) Insensitiveness to shock of impact or firing, so that it can be safely handled and transported. A rifle bullet fired through a case of TNT has no ex-

---

*From the Journal of Industrial and Engineering Chemistry, August, 1917.

plosive effect, and covering with either sand or water has no effect on shattering force.

The velocity of detonation is less than picric acid, 7,100 meters per second against 7,600.

The expansive force test shown in the "Trausel lead block" method gives for TNT 218 cc. against 228 for picric acid. These figures may vary with different grades of material and are merely cited for comparison.

The lower expansive or shattering force is in some instances advantageous; for example, a shell blown into very small pieces will not have the disastrous effect produced if the fragments are larger.

Used in detonators, TNT replaces the more expensive mercury fulminate; e. g., in a No. 7 cap, containing 1.5 g. of fulminate, 0.7 g. of TNT will replace 0.5 g. of fulminate.

TNT is also used as a component of many explosive mixtures, having greater effect if combined with compounds like chlorates and nitrates These furnish oxygen for the complete combustion of the TNT, which is decidedly lacking in oxygen, and when exploded alone gives a dense black smoke.

Inspection.

TNT is on the market in two grades, primarily, crude and refined. The crude has not been recrystallized from solvents, while the refined has. Of these two grades, there may be several other grades based on the melting point (M. P.) or usually the solidification point (S. P.).

The crude TNT is the more common in the U. S., and when purchased by foreign governments is shipped crude and either refined or blended with other substances. The greater bulk of TNT made, up to very recently, has been shipped crude, probably only three plants in the U. S. manufacturing the refined grade in any quantity. In the different plants the product is obtained in lots of approximately 2,200 lbs. each, called "runs."

The specifications usually call for containers, such as cases or kegs, which hold from 60 to 100 lbs., are lined with oiled paper, and numbered as to shipment, "run" and case. The inspector may be expected to check the weights, and take samples for analysis.

Sampling.

Samples should represent amounts of 4,000 lbs., and for convenience a composite sample from two runs is often taken. The cases are selected, opened, the samples taken from different parts of the case, mixed, and three 1-lb. bottles filled: one each for buyer, seller, and referee, the latter's bottle being sealed by the buyer's inspector.

Testing.

COLOR should be light yellow for crude, cream for refined.

Comment—The color changes rapidly when exposed to strong light, sunlight changing it from yellow to orange in 15 to 20 minuts, although usually the deeper shades of yellow are not an indication of impurity. The brownish grades should be inspected, though not necessarily condemned in the crude grade without confirmatory tests.

In the refined grade the color may vary with the solvent used in recrystallizing, but should usually be of a light cream, melting to a clear light brown, not darkening appreciably at 100° C. for 2 hours.

FINENESS—For crude, 90 per cent shall pass through a 10-mesh sieve. For refined, 99 per cent shall pass through a 12-mesh sieve. For exploders, all shall pass through a 30-mesh sieve.

Comment—The crude may contain frequently 7 to 8 per cent of lumps larger than specified, but usually is O. K., always being sieved before packing, and the lumps forming on the sides of the crystallizing tub have been allowed, intentionally or accidentally, to get into the sieved product.

MOISTURE shall not be more than 0.10 per cent for crude or refined (some specifications allow 0.15 per cent) and shall be determined by drying 2 g. over sulfuric acid for 24 hours.

Comment—The method is efficient and will remove as much as 30 per cent of moisture in the time specified.

ACIDITY—There must be no acidity. This determination is made by shaking 10 g., melted, with 100 cc. boiling distilled water, allowing to cool, pouring off the water extract into a flask, and reserving. The operation is repeated with 50 cc. water, adding the second extract to the first. The combined extraction is titrated with N/12 caustic alkali, using phenolphthalein as indicator.

Other specifications, less definite, are as follows: Shake 5 g. with 100 cc. of distilled water in a 100 cc. graduated cylinder one minute, add blue litmus paper and let stand 30 minutes, with occasional shaking. The paper must not show any acid reaction at the end of this time.

One specification allows 0.03 per cent acid calculated as sulfuric.

Comment—The method of the first specification seems better, although any sodium bicarbonate washing (not used at present) will give acid reaction at this point, whereas methyl orange will indicate only the mineral acids. The litmus paper shows acidity with phenolic compounds as well as acids, but if the determination is carried out as specified, there will be no color to the litmus paper, i having been completely bleached, and any acid reaction is more or less doubtful. The method may be modified as follows: Shake 5 g. with 400 cc. distilled water 1 minute, *filter*, let stand 5 minutes and add the litmus paper. Any acid reaction will be detected in 2 minutes. The litmus might be used instead of titrating in the first method.

INSOLUBLE MATTER must not exceed 0.15 per cent, as determined by boiling 10 g. with 150 cc. of 95 per cent alcohol, collecting on weighed

Gooch crucible, washing with not more than 150 cc. of 95 per cent alcohol, drying at 95° C. 1 hour and weighing.

Some specifications call for benzene as the solvent and allow 0.1 per cent for refined, 0.15 per cent for medium, and 0.2 per cent for crude.

Comment—The method is efficient.

Turbidity in the wash water is one cause for high insoluble matter, and another is allowing the TNT to stand too long in the lead-lined wash tanks, the acid attacking the lead and forming lead salts.

ASH IN CRUDE TNT must not exceed 0.10 per cent, determined by lighting 1 g. in a platinum crucible, allowing to burn slowly and igniting completely, precaution being taken to prevent loss of ash.

Comment—The sample should be heated, ignited directly with the flame and allowed to burn without first melting. If melted and then heated further the sudden combustion will expel it from the crucible.

The size of the sample should be about 2g., taking into consideration the low percentage of ash present.

The residue, called "insoluble matter," might be conveniently used for the ash determination.

Some specifications call for sulfated ash, probably to avoid loss of potassium or sodium salts during ignition.

ASH IN REFINED TNT for exploders must be less than 0.05 per cent.

NITROGEN—Crude TNT must not contain less than 18.00 per cent of nitrogen determined by the Dumas combustion method.

Refined TNT must not contain less than 18.2 per cent. of nitrogen determined by the Dumas combustion method.

Comment—The Dumas method, standard for nitrogen, requires little comment, results being very satisfactory, although it is necessary to make determinations on a substance of standard nitrogen content.

The method requires from 1½ to 2 hours, and unless the chemist possesses several furnaces, not very many determinations can be made daily.

For the nitrogen determination of many organic compounds, the Gunning-Arnold method or a modification of it has been used. The only modifications reported to be satisfactory for trinitro-toluene, or other nitro compounds, are the zinc-dust reduction by W. C. Cope, U. S. Bureau of Mines, and the use of nitron as a reagent, by W. C. Cope and J. Barub, *J. Am. Chem. Soc.*, 39 (1914), 504-14.

The nitrogen determination is important, although if the melting point or solidification point is up to specifications, the nitrogen is seldom below.

In many instances it as a common practice to average several samples for the determination of nitrogen.

DIPHENYLAMINE TEST—Crude TNT shall contain no products which will give the nitric acid reaction with the sulfuric solution of diphenylamine. The determination is made by shaking with 50 cc. distilled water in a graduated glass-stoppered cylinder, letting stand for 15 minutes, filtering and testing a few drops of the filtrate by addition to a diphenylamine solution. No nitric acid reaction should be obtained.

Comment—The blue color, characteristic of this reaction, is readily recognized and the test is extremely delicate.

Care must be taken that vessels are free from traces of nitric acid or nitrates.

Since other oxidizing agents, such as chlorine, chlorates, bromates, etc., will respond to this test, it is of more value, as a negative test, and fairly positive because the oxidizing agents mentioned are not likely to be found in trinitro-toluene. A pale blue color is not confirmative; and color should be deep blue.

Melting Point.

THE MELTING POINT of crude TNT must be 75.5° C. or higher.

Note—This is the mean, some specifications call for a melting point of 74.5° C., others 76.5° C.

Medium TNT must have a melting point of 79.5° to 81.5° C.

Refined TNT for exploders must melt from 80° to 81.5° C.

Comment—Methods for obtaining melting points are not usually given in the specifications, but it is absolutely necessary that a definite procedure and definite apparatus be agreed upon. The following points should be taken into consideration: calibration and stem correction of thermometers, size of tubes, amount of substance taken, degrees of melting at which reading is to be taken, rate of melting and vessel or liquid to be used as bath.

The following is given by H. B. P. Humphries, Engineer:

APPARATUS AND METHOD—A beaker of 1,500 cc. capacity should be filled ¾ full with distilled water, heated by an adjustable Bunsen, arranged with a mechanical stirrer, with the center of the blade level with the thermometer bulb, clearing it by ½ in. The thermometer should be graduated in tenths of a degree, and lowered so that the bulb is 1-3 the height of the beaker from the bottom and 1 inch from the side.

Tubes should be made from thin-walled 6 in. x ½ in. test tubes drawn out into 1-16 in. internal diameter, cut into 3 in. lengths, and sealed at one end.

Set the stirrer going and heat until the temperature is about 15° C. below the melting point. Meanwhile introduce a ¼ to ⅜ in. column of the powdered sample (previously dried at a suitable temperature) into a tube and tap and tamp down gently. Attach the tube to the thermometer by a rubber ring so that the center of the column of material is level with the center of the thermometer bulb, and replace the thermometer as before. Reduce the heat so that the temperature rises 1° in 2 or 3 minutes. The slower rate should be adopted if several determinations are made at the same time.

Readings—Note the temperature when:

(*a*) The first globule of melted material is observed;

(*b*) The material is half molten and half unmelted;

(*c*) The melting is complete and a clear liquid occupies the tube.

Record these readings and call (*b*) the uncorrected melting point.

CORRECTED M. P.—Correct the readings for

(*Concluded on page 64*)

ARTIFICIAL COLORS

Artificial Colors Used in the United States

By H. Walford Martin

When the so-called "Dyestuff Census," or list of the "Artificial Colors used in the United States," was prepared by the Bureau of Foreign and Domestic Commerce in 1916, it was desired to supplement the statistical matter collected on our imports for the fiscal year 1913-14, by summaries classing the data under the more specific heads of color, methods of application, etc. The urgent demand for a speedy appearance of the "Census" rendered this impossible. No classification was attempted beyond the fundamental division into groups based on chemical nature, as employed in the standard "Farbstofftabellen" of G. Schultz, in general use among tinctorial chemists.

In the September issue of the "Journal of the Society of Dyers and Colourists" Mr. H. Walford Martin publishes the results of a careful grouping of the data furnished by the "Census," regarded from the standpoint of the dyer.

These groupings are of great value and throw a most interesting light on the relative importance of different dyes and different classes of dyes, in the American consumption of synthetic colors.

On the basis of color, the dyes imported in 1913-14 may be grouped as follows:

	Per cent.
Black	36
Blue	32
Red	9.3
Yellow	7.5
Brown	4.
Orange	2.5
Green	2.5
Violet	2.2

On the basis of method of application the percentages are as follows:

	Per cent.
Direct Cotton	21.6
Indigo	21.3
Sulfur	16.8
Acid	15.8
Mordant	11.0
Basic	6.0
Vat	4.0
Lake	3.3

These figures explain easily why the efforts of the young dyestuff industry were so largely directed in 1915 to securing, first of all, an ample output of blacks, and were then gradually led to the blues.

T. H. N.

THE UNITED STATES AS A DYESTUFF MARKET.

Until the publication of the U. S. Dyestuff Census there was no authoritative record of the dyestuffs which have commercial importance or of the extent to which they are used. As a consequence the text books contain elaborate descriptions of dyestuffs brought out with great expectations which never materialized, while colors which command extensive sales are passed over in a few sentences or are not mentioned at all. The field is, however, so extensive and so intricate that many of the figures are incomplete and misleading. Nevertheless the outstanding features of the situation can be presented with substantial accuracy even though approximately 200,000 lbs., say 1%, of the total importations, have not been identified by the writer, and in other cases importations have not been correctly identified.

In the lists which follow the first figure is the number assigned to the dyestuff in Schultz's 1914 "Tables," the second figure represents the importation in pounds for the year ending June, 1914. The firm name has been attached where it appears that the figures substantially represent the importations of one factory. Where the products of many factories have been imported, the attempt has been made in numerous cases to use the designation of the firm with the largest share in the business. The classifications are of course arbitrary and overlap each other.

(1) Alizarine Colors, Etc.

This includes the chrome-topped colors, the acid Alizarine colors, of which certain are used as ordinary acid colors, the fast one-dip colors, not generally used as acid colors.

In *Red* the most important group is Alizarine with importations of 359,043 lbs., followed by 59,875 lbs. of one-dip reds, 24,139 lbs. of chrome-topped reds and 10,917 lbs. of acid Alizarine Red. The most important colors are:

778	Alizarine paste	302,836
780	Alizarine Red W pdr	53,154
202	Palatine Chrome Red B (B)	7,374
29	Eriochrome Red B, AW, (G)	5,491
182	Brilliant Sulphon Red B, 5B.	
	Fast Sulphon Violet 4R (S)	4,871
400	Acid Anthracene Red 38	14,120
	Milling Red 6BA, GA, (Ber)	4,540
	Alizarine Rubinol R, 5G (By)	10,917

In *Orange* the chrome topped group leads with importations of 40,159 lbs. followed by 14,739 lbs. of Alizarine Orange and 11,977 lbs. of one-dip orange. The most important colors are:

		Pounds
779	Alizarine Orange paste and pdr	14,739
58	Mordant Yellow 3R	37,544
250	Milling Orange	10,427

In *Yellow* the most important group is the chrome-topped, with importations of 423,466 lbs., followed by 18,290 lbs. of one-dip yellow and only 5,884 lbs. of Alizarine Yellow. The most important colors are:

		Pounds
773	Anthracene Yellow	5,046
294	Fast Mordant Yellow G	3,678
102	Diamond Flavine G (By)	23,089
96	Chrome Fast Yellow	15,165
177	Mordant Yellow	85,003
“	Alizarine Yellow O (M)	59,000
“	Salicine Yellows (K)	23,068
“	Anthracene Yellows (C)	16,050
48	Alizarine Yellow 2G paste and pdr	152,884
	Sulphon Yellows (By)	7,698
	Milling Yellow O	10,592

In *Green* the Alizarine Cyanine Green group leads with importations or 135,513 lbs., followed by 65,335 lbs. of chrome-topped green, 32,184 lbs. of Alizarine Green and 8,626 lbs. of one-dip green. The most important colors are:

		Pounds
805	Alizarine Green S (M)	15,885
808	Alizarine Green S paste (B)	11,096
601	Coeruleine paste and pdr. (B)	3,404
865	Alizarine Green CG Ex. etc. (By)	124,095
863	Anthraquinone Blue Green BXO (B)	6,552
276	Palatine Chrome Green G (B)	19,665
“	Diamond Greens (By)	8,622
	Chrome Fast Greens (I)	12,943
	Eriochrome Greens (G)	7,220
91	Anthracyl Chrome Green D (D)	4,596
	Salicine Dark Green CS (K)	5,458

In *Blue* the Alizarine Blue group leads with importations of 682,697 lbs., followed by 347,465 lbs. of the Sulphoncyanine group, 276,679 lbs. of the chrome-topped blues and 134,444 lbs. of the Alizarine Saphirol group. The most important colors are:

		Pounds
803	Alizarine Blue WX paste	16,575
804	Alizarine Blue SB (M)	12,400
	Alizarine Blues, various	302,319
	(Alizarine Cyanides etc.)	
	Alizarine Pure Blue DPH (M)	31,000
789	Anthracene Blues WR, W3R, (B)	107,778
800	Anthracene Blues WB, WG, (B)	54,712
801	Anthracene Blues SWGG, WN, (B)	22,444
	also includes SWR, SWG, of 789, 90	
	Anthracene Dark Blue W (B)	4,198
	Alizarine Dark Blue S, DR (M)	6,300
667	Brilliant Alizarine Blues, etc	19,060
599	Galleine pdr	15,404
626	Gallocyanine	78,253
163	Chrome Blue	Cp. Acid Color List
163	Chrome Blue	Cp. Acid Color List
	Probably 100,000 lbs. Carmoisines are used chrome-topped.	
	Palatine Chrome Blue 2B WBB (B)	42,244
	Acid Chrome Blue 3G 2R 5R (By)	25,633
	Anthracyl Chrome Blue 2B D (D)	24,979
	Chrome Fast Blue 4B (Ber)	23,585
	Omega Chrome Cyanine R (S)	21,001
	Fast Mordant Blues B R (M)	17,000
	Salicine Blue B (K)	16,224
	Metachrome Blue B, G (Ber)	14,301
	Chrome Fast Cyanine G (I)	9,511
	Anthracene Chrome Blues (C)	5,027
	Anthracene Acid Blues (C)	4,968
51	Eriochrome Azurol B (G)	21,070
552	Chromal Blue G conc. GC (G)	1,235
257	Sulphoncyanine	159,024
	Indocyanines (Ber)	70,495
	Wool Fast Blue BL GL	28,865
188	Sulphon Acid Blue R	45,038
189	Sulphon Acid Blue B	35,112
858	Alizarine Blue SAP SAE etc	79,679
855	Alizarine Sky Blue B pdr. (By)	19,471
851	Alizarine Direct Blue EB ESB ESR (M)	10,201
859	Cyananthrol R (B)	18,792
	Alizarine Uranol 2B R, (By)	4,947
856	Alizarine Astrol S (By)	
852	Alizarine Irisol R (By)	

Obviously misled by the names Alizarine Blues AS & JR, these two dyestuffs are included in "Alizarine Blues various" given above.

In *Violet* the importations are insignificant, viz., 8,457 lbs. of various Gallocyanine products for calico printing, 6,881 lbs. of various chrome-topped violets and 1,202 lbs. of Anthraquinone Violet (No. 853).

In *Brown* the chrome-topped group leads with importations of 207,385 lbs., followed by 123,861 lbs. of Alizarine Brown. The most important colors are:

		Pounds
782	Alizarine Brown paste and pdr	115,586
89	Metachrome Browns B BL BRL (Ber)	58,344
88	Acid Anthracene Browns (By)	33,053
154	Palatine Chrome Browns (B)	18,264
	Chrome Fast Browns (I)	12,204
	Oxychrome Browns (GrE)	10,490
	Anthracene Chromate Browns (C)	9,548

In *Black* the chrome-topped group leads with importations of 1,617,432 lbs., followed by 749,636 lbs. of Alizarine Black, 171,795 lbs. of the Sulphoncyanine group and 7,554 lbs. of Acid Alizarine Gray. The most important colors are:

		Pounds
774	Alizarine Black S SR WR (B)	136,461
806	Alizarine Blacks (M)	229,500
807	Alizarine Black SE SET SX SXT (M)	198,491
	Patent Alizarine Black	61,500
862	Alizarine Black B 3B	123,684

As these figures include Cassella importations they are probably subject to a deduction of at least 20,000 lbs. for acid black sold in this market as Alizarine Black 4B.

180	Eriochrome Blue Black B (G)	43,880
181	Palatine Chrome Black 6BX	65,658
183	Eriochrome Black T conc. (G)	129,550
184	Eriochrome Black A (G)	96,570
157	Diamond Black PV P2B PVT (By)	285,047
275	Diamond Black	351,582
	Salicine Blacks (K)	177,203
	Chrome Fast Blacks (Ber)	76,451
185	Anthracene Chrome Blacks (C)	51,577
265	Sulphoncyanine Black	69,590
	Nerol B 2B BL 2BL VL (Ber)	65,441
	Alphanol Blacks (C)	30,189
	Acid Alizarine Gray (M)	7,554

(2) Acid Colors.

Reference has already been made to the acid-dyeing Alizarines and to the one-dip colors of exceptional fastness to fulling, but the ordinary acid dyestuffs which have this useful property are given below. Standing somewhat apart from this group are the Eosines with importations of 128,160 lbs., exclusive of the Eosine made here from German intermediates. Acid Rhodamines are also included but the Rhodamines are given with the Basic Colors. In detail the importations are:

		Pounds
587/9	Eosine	59,044
	Bromofluoresceic Acid (M)	38,000
	Acid Eosine (B)	17,499
592	Erythrosines (M)	4,449
593	Phloxines	3,264
595	Rose Bengales	3,631
585	Uranine	2,273
	Anthrosines (B)	3,360
	Acid Rhodamines (B)	7,038

In *Red,* excluding the above mentioned Eosine group, the importations are 1,650,000 lbs., of which 818,249 lbs. are Scarlet. The most impotrant colors are:

		Pounds
524	Acid Magenta	19,098
147	Azofuchsine 6B	28,704
	Guinea Bordeaux B BL 6B (Ber)	23,252
672	Azo Carmine GX (B)	17,500
	Wool Cerise SR (K)	16,038
112	Bordeaux B	44,521
168	Amaranth	88,571
66	Amido Naphthol Red 2B (M)	36,000
	Azo Rhodine 2B (S)	10,108
42	Amido Naphthol Red G	4,999
64	Azo Acid Magenta G (M)	10,000
146	Azofuchsine G (By)	17,819
40	Chromotrop 2R (M)	5,000
57	Chromotrop S DW (M)	7,500
	Brilliant Carmines (B)	6,383
249	Croceine Scarlet 10 B (By)	7,275
163	Azo Rubine etc	251,477
	Carpet Reds (K)	15,445
161	Fast Red A	52,036
	Brilliant Lanafuchsine (C)	11,289
64	Lanafuchsine SG etc	80,659
	Acid Reds (K)	30,099
	Guinea Fast Reds (Ber)	5,619
248	Fast Scarlet B	4,848
169	Brilliant Croceine	150,897
82	Ponceau 2RL etc. (Ber)	20,972
	Scarlet (Ber)	13,344
82	Scarlet S2R etc. (B)	88,883
	Brilliant Scarlets (B)	36,162
82	Scarlets (M)	209,281
	Victoria Scarlets (M)	22,400
82	Scarlets (C)	36,598
	Brilliant Scarlets (C)	41,082
	Brilliant Scarlets (tM)	28,501
82	Scarlet (D)	12,210

In *Orange* the importations are 367,265 lbs., exclusive of the considerable amount of Orange II made here from German intermediates. The most important colors are:

		Pounds
	Orange RO	114,435
145	Orange II	127,550
144	Orange I	8,305
37	Croceine Orange G	11,366
70	Croceine Orange R	21,480
38	Orange crystals	55,548
139	Orange IV	19,520

In *Yellow* the importations total 1,301,979 lbs. The most important colors are:

		Pounds
143	Tropaeoline etc	16,186
134	Metanil Yellow	284,606
140	Azo Yellow	154,538
137	Fast Yellow Y	35,982
22	Xylene Yellows	23,074
19	Fast Light Yellows	52,328
20	Flavazine S (M)	19,000
	Flavazine 3GL T (M)	62,375
23	Tartrazine	266,978
	Wool Yellows (K)	17,465
7	Naphthol Yellow	250,409
613	Quinoline Yellow	104,082

In *Green* 585,395 lbs. were imported, inclusive of greenish blues of the Patent Blue type. The most important are:

		Pounds
505	Light Green SF yellowish	79,435
502	Guinea Green B, G (Ber)	14,666
	Acid Green (tM)	35,305
503	Neptune Green SGX	40,868
564	Naphthalene Green	21,144
566	Wool Green S Ex. Conc	41,584
	Wool Green (K)	20,255
	Cyanol Greens (C)	10,988
523	Fast Greens (By)	14,347
	Cyanol Fast Greens (C)	7,501
	Guinea Fast Greens (Ber)	5,236
545	Patent Blue A	64,339
543	Patent Blue V	144,827
506	Erioglaucine (G)	66,526
507	Xylene Blues (S)	10,368

In *Blues* the total importations were 1,151,123 lbs. The most important colors are:

		Pounds
877	Indigo Extract	19,329
546	Cyanols (C)	40,015
	Wool Blues (K)	23,020
565	Wool Blues (Ber) (Lev)	173,904
	Brilliant Milling Blues (C)	7,322
562	Fast Acid Blue B (By)	7,725
	Wool Blues (By)	25,065
	XL Blue (RH)	10,047
536	Alkali Blues	287,024
521	Aniline Blues	50,563
537	Soluble Blues	187,710
699	Induline	47,864
	Patent Marine Blue LER (M)	51,500
	Naphthalene Blues (M)	28,000
544	Cyanine B	8,698
531	Eriocyanine (G)	25,091
	Naphthazine Navy Blue (D)	5,996
63	Azo Acid Blue B	44,258
	Orthocyanine (Ber)	5,406
	Fast Acid Marine Blue HBE (B)	25,567
	Azo Fast Blues (C)	7,994
187	Lanacyl Blue (C)	4,200

In *Violet* the importations total 409,853 lbs., of which 227,124 lbs. were the regular Acid Violet. The most important colors are:

		Pounds
	Wool Violet R SL (K)	12,584
	Erio Violet BC RLC (G)	21,345
61	Victoria Violet	47,457
	Azo Fast Violet (C)	7,998
	Indo Violet BF (Ber)	23,060
186	Lanacyl Violet (C)	3,628
	Azo Wool Violet 7R 4B (C)	12,944
	Biebrich Acid Violet R (K)	4,982
	Neutral Violet O (M)	4,000
528	Fast Acid Violet 10B (By)	12,919
527	Acid Violets, various	176,532
	Formyl Violets (C)	19,819
	Guinea Violet 4B 6B (Ber)	18,854
532	Alkali Violet	6,338
580	Violamines	29,090

In *Brown* the importations total 171,648 lbs., of which a considerable proportion are mixtures. The most important products are:

		Pounds
160	Fast Brown N (B)	67,531
	Wool Browns (K)	40,736
211	Resorcine Brown	13,189
	Acid Kraft Brown MAX (B)	4,958

In *Black* importations of Nigrosines (water and spirit soluble) total 649,000 lbs., exclusive of the considerable amount manufactured here. In Acid Blacks importations total 1,752,258 lbs. The most important colors are:

		Pounds
	Nerazine G GA (C)	44,676
700	Nigrosines	604,325
	Amine Black Green B	13,199
	Wool Blacks (K)	118,791
	Naphthol Blacks (K)	83,502
266	Naphthylamine Blacks (B) (K)	106,403
“	“ “ (By)	122,581
“	“ “ (C)	45,738
	Amine Blacks (Ber)	146,163
	Wool Blacks (Ber)	110,244
217	Agalma Black 10BX	40,763
	Naphthol Blue Blacks (C)	62,864
220	Palatine Blacks	148,203
272	Brilliant Blacks (B)	39,454

(3) Specialties for Lakes.

Many of the dyestuffs used for this purpose are included in their respective lists. Certain acid dyestuffs adapted to this purpose only are given below It will be noted that Red is by far the most important color, with importations of 987,715 lbs.

		Pounds
	Claret Lake BL (By)	15,290
	Helio Bordeaux BL (By)	14,703
	Hansa Rubine G O (M)	6,000
152	Permanent Red 4B	44,850
	Permanent Red B R 4R (Ber)	56,545
132	Lake Red P (M)	60,345
153	Lake Red C Extra (M)	306,607
45	Brilliant Lake Red R (M)	31,674
173	Lithol Red R (B)	214,448
	Lithol Reds various (B)	67,515
73	Helio Fast Red RL (By)	13,413
	Lithol Fast Scarlets (B)	36,295
	Paratol Scarlet 3B (M)	41,000
56	Autol Red BL paste (B)	49,847
	Red Lake RL (By)	9,686
	Lithol Fast Orange R (B)	36,641
	Quercitron Substitute V WBL (B)	16,812
	Paratol Chrome Yellow L (M)	17,336
	Hansa Yellows (M)	11,014
4	Naphthol Green B	19,146
	Lake Blues (M)	8,887
	Pigment Blacks (B)	22,448

As the following intermediates are chiefly used for lakes the importations are given below. Intermediates, i. e., b-naphthol, p-nitraniline, used both for lakes and in dyeing are given later.

	Pounds
m.—Nitro—p. toluidine	10,513
o.— “ —“— “	20,737
p.— “ —o.— “	30,642

(4) Vat Colors.

Up to this point the colors enumerated are principally used for Wool; the classifications which follow refer, generally speaking, to Cotton colors. The figures in this group refer to a business which as regards Indigo is a development of the last fifteen years and of not much more than half this period in the case of the other colors. It is interesting to note that Blue predominates in this group to the extent of 93%. Even with Indigo excluded the proportion is 62%. The total importations are 10,322,683 lbs., or excluding Indigo 1,815,324 lbs.

In *Red* the importations were 148,526 lbs. The most important colors are:

		Pounds
827	Indanthrene Claret B Extra (B)	28,728
918	Helindone Red 3B	27,874
831	Indanthrene Red BN Extra (B)	6.056
910	Helindone Pink AN BN	39,393
907	Ciba Scarlet G 20%	22,265
916	Helindone Scarlet S	5,515

In *Orange* the importations were 94,938 lbs. The most important colors are:

		Pounds
761	Indanthrene Golden Orange R (B)	50,496
760	“ “ “ G (B)	20,092
913	Helindone Orange R	14,489
822	Algol Brilliant Orange FR (By)	6,195

In *Yellow* the importations were 115,838 lbs. The most important colors are:

		Pounds
849	Indanthrene Yellow G (B)	75,192
810	Helindone Yellows CG RN (M)	20,744
759	Anthraflavone G (B)	7.143
814	Algol Yellow WF (By)	5,185
817	Algol Yellow R (By)	4,887

In *Green*, excluding Indanthrene Green B, which is largely used for black, the importations total only 19,180 lbs. The most important color is:

		Pounds
833	Algol Olive R (By)	13,334

In *Blue* the importations total 9,645,821. lbs. Excluding Indigo the various Indanthrene Blues account for 728,194 lbs. out of a total of 1,138,462 lbs. The most important colors are:

		Pounds
874	Indigo	8,507,359
888	“ G	10,730
879	“ R	53,610
880	“ RB	6,856
886	Brilliant Indigo G (B)	12,057
885	“ “ B (B)	8,175
881	Ciba Blue 2B	16,880
748	Hydrone Blues (C)	292,729
842	Indanthrene Blue GCD (B)	478,980
841	“ “ 2GS (B)	10,163
	“ “ WR (B)	31,658
838	“ “ RS (B)	187,379
763	“ Dark Blue BO (B)	11.096
839	Algol Blue 3G (By)	5,994

In *Violet* the importations total 153,738 lbs. The most important colors are:

		Pounds
767	Indanthrene Violet 2R Extra (B)	68,419
832	“ “ RN “ (B)	11 667
820	Algol Brilliant Violet R (By)	12,784
901	Ciba Violet B (I)	19,830
920	Helindone Violet B 2B R	28,607

In *Brown* the importations are only 23,831 lbs The important colors are:

		Pounds
867	Indanthrene Brown B (B)	6.175
904	Helindone Brown G	12,936

In Grey and Black the importations total 130,811 lbs. The important colors are:

		Pounds
834	Algol Grey B 2B (By)	4,192
765	Indanthrene Black B 2B (B)	122,261

(5) Sulphur Colors.

In this group *Black* predominates to the extent of 80% in importations totaling 7,072,676 lbs. The range of shades is incomplete for lack of Red and Orange in clear tones.

In *Yellow* the importations total 111,390 lbs. The most important colors are:

		Pounds
710	Immedial Yellows (C)	13,395
734	Pyrogene Yellows M O (I)	18,515
	Katigene Yellow G 2G GR (By)	55,227
	Thiogene Yellow 2G 5G (M)	5,545

In *Green* the importations total 115,356 lbs., inclusive of 14,398 lbs. of Olive. The most important colors are:

		Pounds
	Immedial Brilliant Green G (C)	4,799
746	Katigene Greens	63,929
	Sulphur Greens (Ber)	9,157
	Thiogene Greens (M)	8,106
	Immedial Yellow Olives (C)	8,293

In *Blue* the importations total 462,053 lbs, the Immedial group with importations of 208,694 lbs. predominating. The most important colors are:

		Pounds
	Immedial New Blue G (C)	37,492
	“ Direct Blue (C)	73,892
	“ Indogenes (C)	90,077
	Sulphur Indigoes (Ber)	10,488
	“ Blues (Ber)	73,434
	Katigene Indigoes (By)	42,157
	“ Direct Blues (By)	11,299
735	Pyrogene Indigoes (I)	22,661
726	“ Blues (I)	10,934
	Thiogene Blues (M)	14,344
	“ Deep Blue (M)	13,106
	“ Cyanines B G (M)	6,540
	Kryogene Direct Blues (B)	11,116
	Thion Direct Blues (K)	7,349
	“ Navy Blues (K)	7,874
	Sulphur Blues (K)	9,899

In *Violet* the importations total only 14.073 lbs. The important colors are:

	Pounds
Katigene Violet R 3R (By)	3,638
Thiogene Violet V (M)	3,898

In *Brown* the importations total 732,397 lbs., with the Katigene group leading. The most important colors are:

		Pounds
	Katigene Red Browns (By)	68,864
	“ Yellow Browns (By)	36,826
	“ Browns-2R V (By)	22,811
	“ Khaki G Extra (By)	14,242
	“ Black Browns (By)	11,006
	“ Cutch B (By)	7,699
	Sulphur Browns (Ber)	79,691
	“ Catechus (Ber)	48,973
	Pyrogene Browns (I)	63,450
739	Immedial Maroon B (C)	15,496
725	“ Browns (C)	23,887
	“ Cutch (C)	37,676
	Thiogene Browns (M)	97,551
	Cachou (Lev)	56,991
	Sulphur Browns (Lev)	21,002
	“ “ (K)	12,735
	Thion Browns (K)	18,579
708	Sulphaniline Browns O R (K)	11,327
	Crossdye Drab (RH)	15,758
	Kryogene Browns (B)	11,962
	Eclipse Browns (G)	8,713

In *Black* the importations total 5,637,407 lbs., of which 75% was apparently from the Berlin plant. The most important brands are:

		Pounds
720	Sulphur Blacks (Ber)	4,206,288
	“ “ (K)	323,715
	Katigene Deep Black B K (By)	224,262
	“ Blue Blacks (By)	49,310
	Thioxine Blacks (GrE)	143,471
	Immedial Brilliant Carbon (C)	113,900
	“ Blacks (C)	51,699
	Kryogene Blacks (B)	121,904
	Thiogene Blacks (M)	83,089
	Solfigene Deep Blacks (I)	61,949
722	Auronal Blacks (G)	50,879
	Crossdye Blacks (RH)	38,583
	Sulphur Blacks (Lev)	33,892

(6) Developed Colors.

Supplementing and serving a similar purpose to the Sulphur colors, these dyestuffs were imported to the extent of 1,644,272 lbs. In addition to these, imports of Formaldehyde colors were 11,444 lbs. and Nitrazol developed colors only 7,986 lbs. As with the Sulphur group Black predominates to the extent of 83% of the total.

In *Red* the importations total 163,083 lbs. The most important colors are:

		Pounds
	Zambesi Rubine B	18,617
	Diazo Bordeaux 7B (By)	7,670
	“ Fast Bordeaux BL (By)	3,194
	“ Brilliant Scarlets (By)	38,909
	Zambesi Scarlets (Ber)	9,321
	Diamine Azo Scarlets (C)	6,646
	Diazanil Scarlets (M)	4,125
616	Primuline	67,976

In *Blue* the importations total 79,523 lbs. The most important colors are:

	Pounds
Naphthogene Blues (Ber)	33,847
Oxamine Fast Blues 2R 6BX (B)	8,435
Diaminogene Blues (C)	8,308
Diamine Azo Blues (C)	3,497
Diaminogene Sky Blue N (C)	3,195
Diazo Sky Blue B 3GL (By)	6,150
“ Indigo Blues (By)	7,484

In *Brown* the importations are only 9.162 lbs The important colors are:

	Pounds
Diazo Browns (By)	5,134
Zambesi Browns (Ber)	4,028

In *Black* the importations total 1,369,065 lbs., excluding Diamine Black BH, which is given with the Direct colors. The most important colors are:

		Pounds
	Zambesi Blacks (Ber)	629,359
274	Diaminogenes (C)	305,944
	Oxydiaminogenes (C)	139,118
	Diamine Neron BB (C)	36,982
308	Diazo Blacks (By)	62,854
	“ Fast Blacks (By)	29,330
	Oxamine Blacks BB RN A BRTX (B)	50,032
	Naphthamine Fast Blacks (K)	34,203

(7) Direct Colors.

In order that their significance may be better grasped an attempt has been made to separate the direct colors claiming special fastness to light from the ordinary direct colors. Of the former the importations were 843,083 lbs., of the latter 6,129,801 lbs.

In *Red* the importations total 75,665 lbs. for fast-to-light colors and 912,121 lbs. for the ordinary colors. The most important are:

		Pounds
	Benzo Fast Bordeaux 6BL (By)	6,056
332	“ “ Reds (By)	5,985
	Solamine Red (Ber)	3,179
343	Benzamine Fast Red F	52,911
297	Benzo Fast Pink 2BL (By)	3,252
312	Congo Corinth G	39,748
313	“ Rubine	48,461
	Oxamine Claret B (B)	6,701
	Benzo Rubine HW SC (By)	4,795
	“ Bordeaux 6B (By)	7,271
	Diamine Brilliant Bordeaux R (C)	12,288
	Columbia Bordeaux B (Ber)	6,178
	Benzo Rhoduline Red B 3B (By)	11,873
121	Erica B Extra	6,149
119	Diamine Rose (C)	5,269
118	Brilliant Geranine, Geranine G (By)	18,917
	Benzo Red 10B 12B (By)	19,420
405	Benzopurpurine 10B	47,708
	Chicago Red III (G)	13,195

358	Diphenyl Red 8B	12,808
	Chloramine Red 8BS (By)	9,748
194	Thiazine Reds R G	7,938
	Direct Red N (K)	5,754
346	Oxamine Red, BNX H 3B (B)	11,636
279	Benzo Fast Scarlets (By)	36,674
	Diamine Fast Scarlets (C)	9,632
319	Diamine Scarlets (C)	28,887
	Direct Scarlets B 3B (S)	4,903
	Diamine Brilliant Scarlet S (C)	5,409
366	Deltapurpurin 5B	20,284
368	Brilliant Purpurin 10B (Ber)	6,634
369	" " R (Ber)	8,051
370	" Congo R	19,133
365	Benzopurpurine	21,090
363	Benzopurpurine 4B	341,724
	Diamine Reds (C)	9,988
307	Congo	12,040

In *Orange* the importations total 23,340 lbs. in fast-to-light colors and 285,125 lbs. in ordinary colors. The most important products are:

		Pounds
	Benzo Fast Orange S 2RL (By)	3,484
	Diamine Fast Oranges (C)	17,387
	Columbia Orange R (Ber)	16,351
360	Pyramine Orange R (B)	22,328
	Diamine Oranges (C)	17,068
362	Oxydiamine Oranges	19,095
315	Congo Orange R	7,027
	Naphthamine Oranges (K)	7,607
	Cotton Oranges (K)	21,665
392	Toluylene Orange G	55,562
	Pyramine Orange 2GX (B)	6,003
306	" " 3G (B)	7,863
339	Brilliant Orange G (Ber)	6,321
210	Cotton Orange R (B)	9,997
13	Diphenyl Orange 2G (G)	13,646
11	Chloramine Orange G	24,688
	Chlorantine Oranges (I)	5,189

In *Yellow* the distinction between fast-to-light and ordinary colors is not as marked as with other shades. Only in isolated cases is the fastness to light really poor. Importations total 1,103,419 lbs. The most important colors are:

		Pounds
9/10	Distinct Yellow	332,532
	inclusive of	
	Stilbene Yellows (B)	85,795
	Direct Yellows (K)	79,055
	" " R Extra, etc.	71,399
	Naphthamine Yellows (K)	42,180
14	Diphenyl Chrysoines (G)	9,898
18	" Chlorine Yellows (G)	9,656
191	Pyramine Yellow R (B)	5,727
286	Toluylene Yellow OO (GrE)	5,485
617	Diamine Fast Yellow B, etc.	182,699
	inclusive of	
	Diamine Fast Yellows (C)	88,688
	Columbia and Chloramine Yellows	86,090
	Paper Yellows (B)	264,443
303	" " 3GX	12,241
304	Chrysophenine	179,752
198	Thiazol Yellow	30,953
199	Cotton Yellow R	9,205
296	" " Gl	21,437
	Benzo Fast Yellow 4GL RL (By)	6,535
615	Thioflavine S	4,948
394	Chrysamine R	6,261

In *Green* there is no fast-to-light direct color Importations total 250,978 lbs. In this group the variations in shade and properties are small. 221.708 lbs. of this amount represents products similar to or identical with Diamine Green The most important colors are:

		Pounds
474	Diamine Greens (C)	53,268
	Direct Green (Gr)	31,194
474	Oxamine Greens (B)	31,161
478	Columbia Greens (Ber)	24,749
	Diphenyl Greens (G)	18,021
	Benzo Greens (By)	16,506
	" Dark Greens	23,414

In *Blue* the imports of the fast-to-light brands were 104,944 lbs. out of a total of 1,048,824 lbs., to which should be added 699,588 lbs. Diamine Black BH, etc., which is probably most extensively used as a navy blue. Reference has already been made to the 79,523 lbs. of Developed Blue imported. The most important colors are:

		Pounds
	Brilliant Fast Blues (By)	11,513
456	Benzo Fast Blue B BN	73,936
	" " " 2GL 4GL, etc. (By)	26,559
	" " " R (By)	4,449
	Diamine Fast Blues (C)	28,880
	Columbia Fast Blue 2G R Extra (Ber.)	84,661
	Solamine Blue B (Ber)	21,704
	Chlorazol Brilliant Blues (H)	7,203
	Isamine Blues (C)	5,098
	Brilliant Sky Blues (By)	4,002
424	Diamine Sky Blue FF	255,112
426	Benzo Sky Blue	17,401
416	Brilliant Azurine 5G (By)	18,395
410	Benzo Azurine G	78,699
418	Diamine Brilliant Blue G	22,879
419	Chicago Blue RW	15,176
	Oxamine Copper Blues, etc	26,572
337	Benzo Blue 2B	19,035
	Diamond Blues (C)	21,725
	Oxamine Blues (B)	36,764
	Oxamine Dark Blues	23,810
	Direct Blues (K)	57,224
338	Naphthamine Blues (K)	18,898
	Cotton Marine Blues (K)	79,035
	Half Wool Blues (By)	20,714
	Diphenyl Blues, etc. (G)	17,522
	Triazol Blues (GrE)	10,148
	" Dark Blues (GrE)	19,489
	Benzo Chrome Black Blue B (By)	51,315
333	Oxamine Black BHN Extra	667,929
334	Diphenyl Blue Black, etc	31,057

In *Violet* the total importations were 110,641 lbs., of which 16,945 lbs. were fast-to-light brands. The most important colors are:

		Pounds
	Benzo Fast Heliotropes (By)	13,018
327	Diamine Violet N	13,107
	Benzo Violet R (By)	12,467
326	Oxamine Violet	11,514
	Brilliant Benzo Violets, etc	10,480

In *Brown* the total importations were 734 385 lbs., of which 23,000 lbs. were Diamine Benzo and Toluylene Fast Browns. The most important colors are:

		Pounds
	Chlorantine Browns (I)	18,267
	Benzo Chrome Browns (By)	26,768
	Cupranil Browns (I)	24,851
	Direct Brown 3G	248,596
	Inclusive of Oxamine Browns (B)	93,454
	Naphthamine Browns (K)	48,734
	Benzo Browns (By)	42,403
	Oxydiamine Browns (C)	23,498
	Triazol Browns (GrE)	17,067
	Benzamine Browns (D)	16,988
	Diamine Catechines (C)	66,876
344	" Browns M, etc	86,189
	Trisulphon Browns (S)	16,781
	Pluto Browns (By)	14,580
	Thiazine Brown R (B)	12,105
	Oxamine Dark Browns (B)	10,599

In *Grey* the importations were 125,235 lbs. The most important color is:

	Pounds
Benzo Fast Black L (By)	108,598

In *Black* the importations were 3,187,206 lbs., in addition to a considerable bulk manufactured in this country. The most important products are:

		Pounds
46⅔	Direct Deep Black	2,357,613
436	Columbia Black FF Extra, etc	453,141
	“ Fast Blacks (Ber)	88,490
335	Naphthamine Blacks (K)	47,969
469	Chloramine Blacks (S)	39,600

(8) Basic Colors.

The importations of this group of colors total 2,869,000 lbs.

In *Red* the importations total 358,226 lbs. The most important colors are:

		Pounds
573	Rhodamine B Extra	81,209
576	“ 3G Extra	19,568
571	“ 6G Extra	37,515
512	Magenta	158,304
679	Safranine	59,921

In *Orange* the importations were 178,836 lbs. The most important colors are:

		Pounds
33/4	Chrysoidine	174,308
74	Tannin Orange (C)	2,202

In *Yellow* the importations were 778,481 lbs., divided into two groups, Auramine, etc., 489,302 lbs., and Phosphine, etc., 289,079 lbs. The most important colors are:

		Pounds
606	Phosphine	101,858
	Corioflavine (GrE)	40,343
	Diamond Phosphine (C)	30,336
	Patent Phosphine (I)	28,627
607	Rheonines (B)	19,704
608	Euchrysines (B)	15,403
493	Auramine	449,276
618	Thioflavine T	35,224

In *Green* the importations total 347,067 lbs. The most important colors are:

		Pounds
495	Malachite Green	240,328
499	Emerald Green	74,587
660	Methylene Green	30812

In *Blue* the importations were 441,662 lbs. The most important colors are:

		Pounds
498	Turquoise Blue (By)	1,541
653	Nile Blue (B)	1,518
501	Brilliant Glacier Blue (I)	2,495
659	Methylene Blue	185,958
661	Thionine Blue	18,618
663	New Methylene Blue	30,392
559	Victoria Blue B	132,368
	Inclusive of Victoria Blue base	9,344
558	Victoria Blue R	4,171
522	“ “ 4R	9,599
649	Cotton Blue	51,414

In *Violet* the importations were 390,080 lbs. The most important colors are:

		Pounds
518	Ethyl Purple	51,933
516	Crystal Violet	74,259
515	Methyl Violet	255,063
	Methylene Violets, etc	9,825

In *Brown* the importations were 275,194 lbs. The most important colors were:

		Pounds
283/4	Bismarck Brown	206,153
	Kraft Browns (B) (mixtures)	55,042
	Havana Browns “	8,594

In *Black* the importations were 98,989 lbs. The most important colors are:

		Pounds
681	New Fast Grey	29,507
125	Diazine Black	2,630
	Leather Black (mixtures)	34,561
	Corvoline BT (B) “	10,789
	Jet Black “	21,492

(9) Sundries.

Of Oil colors the importations were relatively small, the largest being Oil Orange, 12,000 lbs., and Oil Blacks, $50,000 lbs.

(10) Intermediates.

The most important of those used for dyeing purposes are given below, but the figures also include the amounts used by domestic dyestuff manufacturers before the war.

		Pounds
923	Ursol	52,720
	p—phenylene Diamine	14,616
	m— “ “	37,907
	m—toluylene “	33,355
	b—naphthol	1,030,268
	Naphthol AS	1,997
	Monosulphonic Acid	32,852
	p—nitraniline	506,931
	a—naphthylamine	112,226
	Aniline Oil	1,444,772
	“ Salts	3,083,467

Exportation of Domestic Aniline Colors

Notwithstanding the constantly increasing demands of the domestic market and the handicap caused by munition manufacturers drawing more and more largely on the available supply of toluol and other coal-tar derivatives vitually essential as raw material for the dyestuff industry, exports of aniline colors during September show a gain over the preceding month of $66,800, or 21.9 per cent., according to a statement issued recently by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce. September exports by customs districts indicate that $261,454, or over two-thirds the total value of all aniline colors shipped abroad, passed through New York; $47,913 through the Massachusetts district, $6,515 through West Coast districts, $1,630 across our Mexican border, and the remainder through districts adjacent to Canada.

The total exportation of aniline colors for the first quarter of the current fiscal year amounted to $1,173,439, of which $497,106 worth was shipped in July, distributed among 21 foreign countries; $304,768 in August to 21 countries; and $371,565 in September to 17 countries—or an average monthly exportation of $391,146 for the first quarter in which aniline dyes are shown separately in the statistical classification.

England is our best customer so far, having taken $195,195 of the aniline colors exported during the quarter ending September 30, 1917, followed by British India, with $184,967; Canada, $161,581; Spain, $105,504; France, $86,379; Japan, $80,073; Mexico, $75,353; Italy, $67,484, and other countries with less extensive purchases.

It is worthy of note that the United States is the only country which has succeeded in establishing, since the war began, a successful dyestuff industry capable

(*Concluded on page* 64)

Prospective Nitroglycerine Plant.

The French-Agnew Torpedo Company, Zanesville, Ohio, is considering the erection of a large plant for the manufacture of nitroglycerine at Winchester, Kentucky.

$8,000 Fire at Bine Brothers'.

Fire recently destroyed a portion of the plant of Bine Brothers, Cook's Falls, New York, with loss estimated at about $8,000. The company specializes in the production of sulphur colors.

Dyestuffs, Explosives and Coal-Tar Products.

The Delta Chemical Company, Inc., Manhattan, has been incorporated under the laws of New York to manufacture chemicals, dyestuffs, explosives and coal-tar products. H. Wilkinson, M. Thyvaert and C. Gander are the incorporators of the new firm, which has an active capital of $5,000 and 100 shares of common stock, no par value.

Oils, Greases, Tars, and Chemicals.

The United Ohio and Chemical Corporation has been incorporated under the laws of Delaware with a capital of $2,000,000 by F. A. Armstrong, C. M. Egner and W. S. Randall, Wilmington, Delaware, to deal in and with oils, greases, tars and chemicals.

Alkali and Chemicals.

The Western Alkali Refining Co., Wilmington, Del., has been incorporated with a capital of $2,000,000 to make alkali and chemicals. The incorporators are C. R. Mudge, C. D. Hopkins and A. M. Gorman, Wilmington.

CURRENT WHOLESALE PRICES OF COAL-TAR PRODUCTS

CRUDES.

Anthracene, 80 p. c.	lb.	.50 — ..
Benzol, pure, water white	gal.	.47 — .50
Benzol, 90 p. c.	gal.	.46 — .48
Cresol, U. S. P.	lb.	.18 — .20
o-Cresol	lb.	.30 — .35
Cresylic acid, 95-97 p.c.	gal.	1.10 — 1.15
Naphthalene, Flake	lb.	.09½ — .09¾
Balls	lb.	.10 — .11
Phenol (carbolic acid), U.S.P., cryst., drs.	lb.	.53 — .54
Pitch, various grades	ton	8.00 — 20.00
Solvent naphtha, water white	gal.	.20 — .25
Solvent naphtha, crude, heavy	gal.	.13 — .16
Toluol, pure, water white	gal.	.. — ..
Toluol, commercial, 90 p.c.	gal.	2.00 — 2.30
Xylene, pure	gal.	1.00 — 1.25
Xylene, commercial	gal.	.35 — .40

INTERMEDIATES AND EXPLOSIVES.

Amido - naphthol - disulfonic acid (H acid: 1.8.3.6)	lb.	2.75 — 3.25
Amido-naphthol-sulfonic acid	lb.	— — 1.75
p-Amido-phenol	lb.	4.50 — 5.50
p-Amido phenol hydrochloride	lb.	4.50 — 5.25
Amino-azo-benzene	lb.	1.75 — 1.85
Aniline oil	lb.	.26½ — .27½
Aniline salts	lb.	.30 — .33
Aniline for red	lb.	1.12 — 1.15
Benzaldehyde	lb.	5.00 — 5.50
Benzidine	lb.	1.85 — 1.90
Benzidine sulfate	lb.	1.45 — 1.55
Benzoic acid	lb.	5.50 — 8.00
Crude	lb.	3.00 — 3.50
Benzylchloride	lb.	2.25 — 2.50
Chlor benzene	lb.	.22 — .31
Diamido-phenol	lb.	9.00 — 10.00
Dichloro-benzene	lb.	.35 — .40
o-Dichloro-benzene	lb.	.15 — .16
p-Dichloro-benzene	lb.	.40 — .42
Diethyl anilin	lb.	3.00 — 3.50
Dimethyl aniline	lb.	.59 — .65
Dinitro-benzene	lb.	.33 — .35
m-Dinitro-benzene	lb.	.45 — .50
Dinitrochlor benzene	lb.	.50 — .56
Dinitro-naphthalene	lb.	.44 — .75
Dinitro-phenol	lb.	.56 — .60
Dinitro-toluene	lb.	.55 — .60
Diphenylamine	lb.	1.00 — 1.10
Ethyl-aniline	lb.	1.00 — 1.25
Hydroquinone	lb.	2.00 — 2.10
Hydrazobenzene	lb.	1.50 — 2.00
Naphthionic acid, white	lb.	1.75 — 1.80
a-Naphthol	lb.	1.75 — 2.00
b-Naphthol	lb.	.65 — .70
Sublimed	lb.	.87 — .90
a-Naphthylamine	lb.	.70 — .80
b-Naphthylamine	lb.	1.75 — 2.00
[illegible]	lb.	2.65 — 3.00
p-Nitraniline	lb.	1.25 — 1.35
Nitrobenzene	lb.	.20 — .22
Oil of Mirbane, ref.	lb.	.18 — .20
o-Nitrochloro benzene	lb.	.50 — .56
Nitro-naphthalene	lb.	.44 — .65
Nitrotoluene	lb.	.55 — .65
o-Nitrotoluene	lb.	.80 — .90
p-Nitrotoluene	lb.	1.00 — 1.25
m-Phenylene-diamine	lb.	1.15 — 1.25
p-Phenylene-diamine	lb.	3.50 — 4.50
Phthalic anhydride	lb.	6.40 — 6.50
Picric acid, kegs	lb.	.85 — 1.00
Resorcinol, cryst., U. S. P.	lb.	16.00 — 17.00
Technical	lb.	8.50 — 9.00
Salicylic acid, U. S. P.	lb.	.90 — 1.40
Sulfanilic acid	lb.	.32 — .34
Tetra-nitro-methyl-aniline	lb.	— — 2.50
Tolidine	lb.	2.60 — 2.80
Toluidine	lb.	1.00 — 1.10
o-Toluidine	lb.	.90 — 1.05
p-Toluidine	lb.	2.00 — 2.25
m-Toluylene-diamine	lb.	1.70 — 1.75
Xylidine	lb.	.75 — .80

SYNTHETIC MEDICINALS, FLAVORS AND PERFUMES.

Acetanilide, C. P., bbls.	lb.	.70 — .80
Acetphenetidine	lb.	8.50 — 9.50
Acetyl-salicylic acid, bulk	lb.	3.00 — 3.55
Antipyrine, bulk	lb.	22.00 — 23.00
Bismuth salicylate	lb.	3.15 — 3.20
Calcium sulfocarbolate	lb.	1.40 — 1.45
Ethyl benzoate	lb.	— — 6.50
Phenacetin (Bayer)	oz.	— — 2.40
Phenolphthalein	lb.	9.50 — 10.50
Potassium salicylate	lb.	2.90 — 2.95
Saccharin	lb.	41.00 — 46.00
Salol	lb.	1.65 — 1.75
Sodium benzoate, granulated, U. S. P.	lb.	2.75 — 3.00
Sodium salicylate, U. S. P.	lb.	.85 — .95
Wintergreen oil, Synthetic, U. S. P.	lb.	.87 — .90
Zinc salicylate	lb.	— — 3.25

PHOTOGRAPHIC DEVELOPERS.

Adurol, 16-oz. bottles	ea.	— — 10.00
Agfa (intensifier), 2-oz. bottle		— — .40
Amidol, 1-oz. bottle	oz.	.65 — .75
Dianol, 1-oz. bottle	oz.	— — .80
Eikonogen	oz.	— — .45
Glycin, 1-oz. bottle	oz.	— — .80
Hydroquinone	lb.	2.00 — 2.10
Monomethyl-p-amido-phenol (identical with metol)	oz.	— — 3.50
Nero (identical with amidol), 1 oz.	oz.	— — .30
Ortol, 1-oz. bottle	oz.	— — .80
Pyrogallic acid, crystals	lb.	2.95 — 3.15
Rodinal, 3-oz. bottle	ea.	— — .75

ARTIFICIAL COLORS.

Acid Black	lb.	1.50 — 1.80
Acid Blue	lb.	2.40 — 2.90
Acid Brown	lb.	2.75 — 3.35
Acid Fuchsine	lb.	7.50 — 8.50
Acid Green	lb.	7.25 — 12.00
Acid Orange	lb.	.65 — 1.00
Acid Orange II	lb.	.65 — 1.00
Acid Orange III	lb.	1.50 — 2.00
Acid Red	lb.	1.50 — 2.00
Acid Scarlet	lb.	2.00 — 1.00
Acid Yellow	lb.	1.50 — 2.50
Alizarin Blue	lb.	6.00 — 6.50
Alizarin Blue, bright	lb.	8.50 — 9.50
Alizarin Blue, medium	lb.	6.00 — 7.50
Alizarin Orange	lb.	6.00 — 8.50
Alpine Red	lb.	5.00 — 7.00
Alpine Yellow	lb.	6.50 — 7.50
Auramin	lb.	3.50 — 4.75
Azo Carmine	lb.	[illegible] — 6.50
Azo Yellow	lb.	2.00 — 3.50
Azo Yellow, red shade	lb.	3.00 — 5.00
Bismarck Brown Y	lb.	1.10 — 1.40
Bismarck Brown FF conc.	lb.	2.00 — 2.50
Bismarck Brown 3 R	lb.	2.25 — 3.25
Bismarck Brown R	lb.	1.50 — 2.00
Bright Red	lb.	2.75 — 3.25
Chrysamine Yellow	lb.	1.75 — 2.25
Chrysoidine	lb.	1.40 — 1.50
Chrysoidine R	lb.	1.30 — 2.50
Chrysoidine Y	lb.	1.10 — 2.00
Congo Red	lb.	2.50 — 4.00
Crystal Violet	lb.	6.50 — 7.50
Direct Black	lb.	.90 — 1.10
Direct Blue	lb.	1.75 — 2.25
Direct Sky Blue	lb.	5.50 — 6.50
Direct Brown	lb.	1.75 — 2.25
Direct Bordeaux	lb.	3.50 — 4.00
Direct Fast Red	lb.	3.25 — 4.00
Direct Red	lb.	2.10 — 2.60
Direct Yellow	lb.	1.75 — 2.25
Direct Fast Yellow	lb.	3.00 — 4.00
Direct Violet	lb.	4.25 — 4.50
Eosin	lb.	10.00 — 15.00
Fast Red, 6B extra	lb.	4.50 — 5.00
T extra	lb.	2.00 — 3.75
Fast Scarlet	lb.	2.75 — 3.25
Fuchsine	lb.	7.50 — 12.00
Fur Black, extra	lb.	2.50 — 3.00
Fur Brown B	lb.	2.00 — 3.00
Fur Brown GG	lb.	2.50 — 4.00
Green Crystals	lb.	13.00 — 15.00
Indigo 20 p.c. paste	lb.	1.60 — 2.00
Indigotin	lb.	2.50 — 3.50
Induline	lb.	1.90 — 2.50
Magenta	lb.	6.00 — 8.00
Malachite Green	lb.	8.50 — 12.00
Metanil Yellow	lb.	1.80 — 2.50
Medium Green	lb.	5.00 — 6.00
Methylene Blue, tech.	lb.	3.25 — 3.75
Methyl Violet	lb.	3.25 — 3.75
Naphthol Green	lb.	3.00 — 3.50
Nigrosine, oil sol.	lb.	.85 — 1.25
Nigrosine, sp. sol.	lb.	.75 — 1.25
Nigrosine water sol., blue	lb.	80 — 1.10
Jet	lb.	.80 — 1.00
Naphthylamine Red	lb.	6.50 — 7.00
Oil Black	lb.	.85 — 1.25
Oil Green	lb.	2.00 — 3.00
Oil Orange	lb.	2.00 — 2.50
Oil Scarlet	lb.	2.00 — 2.50
Oil Yellow	lb.	1.80 — 2.50
Orange RG	lb.	2.00 — 2.25
Orange Y, conc.	lb.	1.10 — 1.50
Ponceau	lb.	1.75 — 2.50
Quinoline Yellow	lb.	5.00 — 11.00
Rhodamine	lb.	5.00 — 6.00
Safranine	lb.	7.00 — 8.00
Scarlet 2 R	lb.	5.50 — 6.00
Soluble Blue	lb.	8.00 — 30.00
Sulfur Black	lb.	.50 — .75
Sulfur Black, 150 p.c.	lb.	1.50 — 2.25
Sulfur Blue	lb.	2.60 — 3.25
Sulfur Blue-Black	lb.	2.00 — 3.00
Sulfur Brown	lb.	.50 — .60
Sulfur Green	lb.	2.00 — 3.00
Sulfur Yellow	lb.	1.80 — 2.50
Tartrazine	lb.	1.25 — 1.75
Wool Orange	lb.	3.00 — 4.00
Victoria Blue	lb.	15.00 — 22.00
Victoria Blue, base	lb.	12.00 — 15.00
Victoria Green	lb.	14.00 — 17.00
Victoria Red	lb.	8.00 — 9.00
Victoria Yellow	lb.	6.75 — 8.25
Yellow for wool	lb.	1.50 — 2.25

NATURAL DYESTUFFS.

Annatto, fine	lb.	.33 — .34
Seed	lb.	.11 — .14½
Carmine No. 40	lb.	4.25 — 4.75
Cochineal, Teneriffe, Silver	lb.	.54 — .55
Gray	lb.	.54 — .55
Indio, Bengal	lb.	3.25 — 3.50
Oudes	lb.	3.00 — 3.25
Guatemala	lb.	2.75 — 3.00
Kurpahs	lb.	2.75 — 3.15
Madras	lb.	1.15 — 1.30
Madder, Dutch	lb.	.27 — .29
Nutgalls, Chinese	lb.	.25 — .26
Turmeric, Madras	lb.	.08¾ — .09½
Aleppey	lb.	.10 — .10½
China	lb.	.08 — .08½

DYEWOODS AND RAW MATERIALS.

Algarobilla	ton	140.00 — 150.00
Barwood	lb.	.06 — .08
Camwood, chips	lb.	.17 — .20
Divi-Divi	ton	60.00 — 65.00
Fustic, sticks	ton	50.00 — 58.00
Chips	lb.	.04½ — .05
Hypernic chips	lb.	.09 — .10
Logwood, sticks	ton	38.00 — 43.00
Chips	lb.	.03 — .03¼
Myrobolans	ton	60.00 — 65.00
Quercitron Bark No. 1	ton	28.00 — 31.00
No. 2	ton	20.00 — 25.00
Red Saunders, chips	lb.	.15 — .17
Sumac, Sicily, 29 p.c. tannin	ton	87.00 — 90.00
Virginia, 25 p.c. tannin	ton	50.00 — 59.00

EXTRACTS.

Archil, double	lb.	.15 — .17
Triple	lb.	.18 — .20
Concentrated	lb.	.21 — .26
Chestnut, 25 p.c. tannin	lb.	.02¼ — .02¾
Clarified, 25 p.c. tannin	lb.	.02½ — .03
Cudbear, French	lb.	.70 — .80
English	lb.	.18 — .24
Concentrated	lb.	.75 — .85
Cutch, Rangoon, boxes	lb.	.16 — .18
Liquid	lb.	.08½ — .09
Tablet	lb.	.10 — .12
Flavine	lb.	1.00 — 1.50
Fustic	lb.	.13 — .16
Gall	lb.	.18 — .32
Gambier, 25 p.c. tannin	lb.	.10 — .10½
Common	lb.	.20 — .20½
Cubes, No. 1	lb.	.22½ — .23
No. 2	lb.	.21 — .21½
Hematine	lb.	.09 — .10
Crystals	lb.	.20 — .28
Indigo, natural, for cotton	lb.	.50 — .54
For wool	lb.	.30 — .32
Indigotin, 100 p.c. pure	lb.	— — 5.50
Logwood, solid	lb.	.19 — .21
Crystals	lb.	.19 — .24
51° Tw.	lb.	.09½ — .12
Myrabolans, 25 p.c. tannin	lb.	.06 — .07
Solid, 50 p.c. tannin	lb.	.10 — .11
Osage Orange—		
Powdered, Aurantine	lb.	— — .25
Paste	lb.	.06 — .12
Persian berries	lb.	— — .75
Quercitron	lb.	.07¼ — .08¼
Sumac, liquid, 25 p.c. tan.	lb.	.06 — .10½

DYEING ACCESSORIES.

Acetic acid, 28 p.c.	lb.	.05½ — .07
56 p.c.	lb.	.11 — .12
Glacial, 99 p.c.	lb.	.36 — .37
Albumen, Egg	lb.	1.05 — 1.10
Blood, imported	lb.	.58 — .61
Domestic	lb.	.53 — .54
Alum, ammonium, lump	lb.	.04¼ — .04½
Alum, chrome	lb.	.25 — .28
Alum, potassium, lump	lb.	.08½ — .09
Aluminum acetate	lb.	.80 — .90
Aluminum chloride, liq.	lb.	.04½ — .05
Aluminum sulfate, techn.	lb.	.02 — .02¼
Aluminum sulfate, iron free	lb.	.03¼ — .03½
Ammonium vanadate	lb.	7.00 — —
Bleaching powder, 35 p.c.	lb.	.01½ — .02¼
Borax, cryst.	lb.	.07¼ — .07½
Citric acid, crystals	lb.	.75 — .75½
Powdered	lb.	.75½ — .76
Copper subacetate (verdigris)	lb.	.40 — .42
Copper sulfate (blue vitriol) 99 p.c.	lb.	.09¾ — .10
Dextrine, corn	100 lbs.	7.00 — 8.00
Dextrine, domestic potato	lb.	.14½ — —
Ferric sulfate, basic (nitrate of iron), comm.	lb.	.01¾ — .02¼
True	lb.	.07½ — .08
Ferrous sulfate (copperas)	100 lbs.	1.00 — 1.50
Formic acid, 75 p.c.	lb.	.40 — .45
Glauber's salt (sodium sulfate)	100 lbs.	.70 — .75
Glycerin, C. P.	lb.	.70 — .71
Gum arabic, firsts	lb.	.55 — .60
Seconds	lb.	.48 — .50
Sorts, amber	lb.	.34 — .35
White	lb.	.46 — .50
Gum tragacanth, Alep., firsts	lb.	2.30 — 2.50
Seconds	lb.	1.94 — 2.00
Thirds	lb.	1.65 — 1.85
Sorts	lb.	.75 — .90
Hydrochloric acid (muriatic) 18°	lb.	.01½ — .02½
20°	lb.	.02 — .02¼
22°	lb.	.02¼ — .02¾
Lactic acid, 22°	lb.	.05½ — .06¼
44°	lb.	.15 — .16
Nitric acid, 36°	lb.	.07¼ — .07½
38°	lb.	.06¾ — .07¼
40°	lb.	.08 — .09
42°	lb.	.09½ — .10½
Oxalic acid	lb.	.46 — .48
Potassium antimony tartrate (tartar emetic)	lb.	.61 — .61½
U. S. P.	lb.	.66 — .70
Potassium bichromate	lb.	.44¾ — .45
Potassium ferricyanide (red prussiate)	lb.	2.60 — 2.70
Potassium ferrocyanide (yellow prussiate)	lb.	1.25 — 1.30
Potassium tartarate, acid (cream of tartar)	lb.	.55 — .60
Prussian blue	lb.	.80 — .90
Soluble	lb.	.95 — 1.00
Sago flour	lb.	.06½ — .07½
Soda ash, light, 58 p.c.	100 lbs.	2.75 — 3.30
Soda, caustic, 76-78 p.c.	100 lbs.	7.75 — 7.90
Sodium acetate	lb.	.14 — .15
Sodium bichromate	lb.	.16¾ — .17½
Sodium bisulfite	lb.	.06 — .06½
Sodium chlorate	lb.	.25 — .26
Sodium ferrocyanide (yellow prussiate)	lb.	.34 — .36
Sodium nitrite techn.	lb.	.35 — .37
Sodium phosphate, com.	lb.	.04½ — .07
Sodium silicate, liquor 60 p.c.	100 lbs.	4.25 — 4.75
Sodium sulfide, 60 p.c., fused	lb.	.03¾ — .04
Crystals, 30 p.c.	lb.	.02¼ — .02½
Sodium thiosulfate (byposulfite)	100 lbs.	1.60 — 1.75
Soluble oil, 50 p.c.	lb.	.10 — .12
75-85 p.c.	lb.	18 — .20
Stannous chloride (tin crystals)	lb.	.55 — .56
Stannic chloride (tin bichloride), 50°	lb.	.23¾ — .24½
Starch, corn, pearl	100 lbs.	6.30 — 6.48
Potato	lb.	.13 — .13½
Rice	lb.	.08 — .10
Wheat	lb.	.05 — .06
Sulfuric acid, 60°	ton	25.00 — 26.00
66°	ton	34.00 — 35.00
Oleum, 20 p.c.	lb.	.02 — .02¼
Tartaric acid, crystals	lb.	.78½ — .80
Turkey Red oil	lb.	.14 — .16
Zinc dust, 350 mesh	lb.	.18 — .25

FOREIGN TRADE OPPORTUNITIES

(See Also Page 77)

General Chemicals.

25781.—A company in Japan who has recently opened a branch office in the United States desires to secure agencies for the sale of machinery, metals, chemicals, electrical motors, etc. Business will be done on a commission basis, or direct purchases will be made. References.

Aniline Colors and Dyestuffs.

25790.—A firm in Italy desires to purchase aniline colors and dyestuffs for cotton and woolen goods. Quotations should be cabled with estimate on freight rates to Genoa. Cash will be paid. Correspondence may be in English.

Chemical Products and Dyestuffs.

25783.—A society in France is in the market for chemical products, pure or for industrial use; dyestuffs and extracts; and pharmaceutical products. Correspondence may be in English. Usual terms are 30 days. References.

Equipment for Small Tannery.

25761.—A firm in Venezuela is in the market for complete equipment for a small tannery. Quotations should be made f. o. b. New York. Payment will be made by cash against documents in New York. Correspondence may be in English. References.

Dyes and Equipment for Woolens.

25551.—A man in Canada desires to purchase dyes and dyers' equipment suitable for dyeing woolen goods. Cash will be paid.

Dyes, Bleaches, Etc.

25643.—An agency is desired by a firm in France for the sale of chemical products, dyestuffs, and all supplies relative to the bleaching, dyeing, printing, and finishing of tissues. Correspondence should be in French. Reference.

Dry Paint, Drugs and Chemicals.

25622.—The representative of a firm in Canada wishes to be placed in communication with American manufacturers and exporters of dry paints, drugs, and chemicals, with a view to securing agencies for the sale of same. All business is desired on a commisssion basis. References.

Explosives for Mining.

25433.—A mining company in Tunisia wishes to communicate with manufacturers of all kinds of mining machinery, including explosives, tools, mine drills, ventilators, mine railways, ore washers, electric motors, machine tools, lubricants, transmissions, steel cables, etc. Correspondence must be in French. References.

The Inspection and Testing of Trinitro-Toluene

(Concluded from page 55)

exposed mercury stem as follows: while the thermometer is registering approximately the melting point, place a drop of melted diphenylamine on the stem and allow to flow down. For a small distance above the water surface the diphenylamine will remain molten: above this it will solidify. Note the point separating the solid from the melted diphenylamine.

Then, if N = No. of degrees of mercury stem exposed above this point.

Ta = Surrounding air temperature and Tm = Melting Point the correction is, $N(Tm - Ta) \times 0.000154$.

Add this correction to the recorded temperature (*b*) for the corrected M. P.

The grading of the TNT being almost entirely dependent upon this determination, the method should be carefully followed.

Comment—The tubes above mentioned seem too large in diameter, and a tube 1 mm. or less in diameter would give a result closer to the real melting point.

One-quarter inch of substance is sufficient, because the higher the column, the more difficult it is to decide when half is melted completely, since this compound does not always melt in one place in the tube, but often at the top and bottom simultaneously, and it is left to the operator's judgment at which point the reading is to be taken.

The three readings are usually taken as a check on each other.

Solidifying Point.

The uncertainty of the M. P. is avoided to a great degree, when the solidifying point is determined. Only one set of specifications gives the method which is described by E. M. Weaver, Brig. General U. S. A. and Chief of Coast Artillery, in his book "Notes on Military Explosives."

METHOD—Place 200 to 250 g. TNT in a dry porcelain dish of 15 cm. diameter and 500 cc. capacity. Melt below 90° C., remove heat and stir with thermometer. The temperature falls gradually until the TNT begins to crystallize, when it rises. Continue stirring until the highest temperature is reached: this is the solidifying point.

Comment—This determination is more apt to give consistent results, and is simple enough so that different operators usually check each other closely.

It is more accurate, since a larger sample is used, and the point of taking the reading more certain than in the M. P. determination.

The above method is followed, without adhering to the size or form of dish. The majority of chemists use smaller dishes, test tubes and beakers without varying results.

Although the M. P. and S. P. are generally considered the same, there is some difference, reports from different chemists showing the S. P. to be in some instances higher and in others lower than the M. P. Some report identical results for the two.

The writer has noted that where the M. P. was higher than the TNT had been dried at 50° C., and where lower, the undried sample had been used. Further evidence is necessary for a decision on this point.

STABILITY TESTS are not usually required on crude material, although some specifications have required it on refined, as follows:

The substance, about 3 g., is placed in a 6-in. test tube having a strip of potassium iodide starch paper suspended on a glass hook which passes through the stopper. The tube with contents is placed in a bath and heated to 65° C. for from 15 to 30 minutes (depending on specification). No blue color showing presence of nitrous acid should develop. This is known as the "Abel" heat test and is usually used on less stable nitro compounds.

Carnegie Institute of Technology, Pittsburgh, Pa.

Exportation of Domestic Aniline Colors

(Concluded from page 61)

of meeting not only the color requirements of its domestic manufacturers of textiles, paper, paints, and pigments, leather, straw, inks, stains, varnishes, waxes, etc., but of exporting considerable quantities to our allies and neutral countries.

Using the quarterly figures as a basis for the estimate, we are now exporting our surplus production of aniline colors at the rate of $4,693,756 annually, or practically twice the value of our entire domestic production for the fiscal year 1914, which amounted to $2,470,096. This refers to values only, which are, of course, much higher comparatively at the present time.

These figures of production and exportation apply to the coal-tar dyes only, and take no account of our equally well developed trade in logwood extract, osage orange, and other vegetable colors.

British Imports of Dyestuffs.

The statistics for the imports of dyeing materials into Great Britain during the month of July 1917, show notable increases in value, as compared with July, 1916, accompanied, however, in some cases, by decreases in quantity. The following are the important items, figures for 1916 being appended in parenthesis:

Cutch	179 long tons	(371)
Dyeing extracts	$567,000	($346,000)
Indigo	41.2 tons	(32.1)
Value	$229,500	($141,600)
Other dyestuffs, including coal-tar colors	672 tons	(1,025)
Value	$952,000	($726,000)

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.

ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

A. S. T.—The sample of clay submitted to me by you for complete chemical analysis and identification has been finished with the results below tabulated:

SiO_2	44.82
Fe_2O_3	25.85
Ae_2O_3	2.63
CaO	7.51
MgO	1.97
K_2O	2.52
Loss on ignition	14.70
	100.00

Have also made a rational analysis of your sample, and report the following fractions:

Clay substance*	66.01
Quartz	32.52
Feldspar	1.47
	100.00

Note.—The texture and grain of this refractory material suit it best for fireclay.

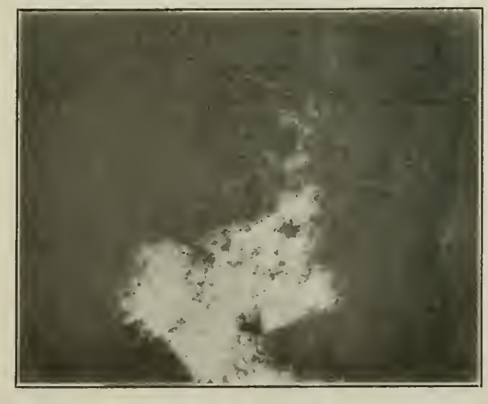
A. W. A.—A kernel of corn is a humble but potent unit. The crop last year amounted to 2,583,241,000 bushels. Of this 40,000,000 was consumed in the manufacture of corn starch, corn syrup and grape sugar.

The following quantities of materials can be produced from one bushel of corn:

1.50 lbs. corn oil.
1.75 lbs. corn oilcake.
10.50 lbs. gluten feed.
1.25 lbs. steep water solids.
41.00 lbs. corn syrup of 41 Beaume, or
41.00 lbs. grape sugar, or
40.00 lbs. dry starch, or
3.00 gal. of 180 proof spirit.

I would suggest that you send me samples from each shipment to test as to moisture, gluten, starch and ash content.

S. S. T.—Syrup such as you describe is manufactured from malt and corn starch. The enzyms Diastase and Hemicellutase are caused to act on the starch and cellulose to produce considerable maltose sugar and some dextrine. These products are used considerably in medicine. The temperatures used can be given you if you so desire. See microphotograph.



D. J. B.—Brewers' yeast, if properly treated to remove the bitter hop principles, may be used for baking by adding an equal weight of distillers' yeast, and prolonging the doughing period.

Hundreds of tons of this yeast from breweries are at present thrown away, but could be used with profit if a process could be devised to purify it.

There is a process at present for converting it into a product quite similar to beef extract.

Charles B Davis

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail are specifically requested, communications can only be considered in the order of their receipt.—Editor.

---

*Kaolinite. Al_2O_3. 2 Sio_2, 2 H_2O.

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By Carleton Ellis and A. A. Wells.[*]

In This, the Ninth Installment of an Article Dealing with Investigations Conducted by the Writers Into the Possible Applications of Ultra Violet Light, the Relative Sterilizing Action of Its Rays Is Discussed, Together With Its Effects on Diphtheria Toxin, Various Enzymes; Its Behavior Toward Wines, Flour, Starch, Artificial Dyes; Its Use in the Vulcanization of Rubber and as an Illuminant in Photography. Part X Will Appear in the January Issue.

PART IX

Relative Sterilizing Action of Ultra Violet Rays.

Cernovodeanu and *Henri* (Comptes. rend. 1910, 150, 549) have compared the photochemical action of various chemical reactions such as: Decomposition of hydrogen peroxide, decomposition of potassium iodide in presence of hydrochloric acid and in presence of starch, reaction between mercuric chloride and ammonium oxalate, oxidation of leuco-derivatives of fluorescein, and the blackening of silver citrate paper. Taking as a standard the action of the rays passing through a glass screen of one millimeter in thickness (wave length over 3022 Angstrom units), the rays passing through a viscous screen having a wave length of over 2534 units, were found to have 300 times the bactericidal power but only 1.6 to 5 times the chemical action, and rays passing through a quartz screen, with a wave length over 2224 units, had only 4-6 times the chemical action, while the sterilizing power had increased to 1,000 times the standard. The germicidal action is therefore a much more characteristic property of the ultra violet rays than the photochemical action. Living organisms are never subjected in nature to ultra violet rays with a wave length under 2800-2900 units, this being the limit of the ultra violet rays reaching the earth from the sun. A Cooper Hewitt mercury lamp of 110 volts and 3 amperes was used for these experiments.

Ozone and Water Formation.

Weigert and *Böhm* (Z. physik. Chem. *90*, 189; Chem. Abs. 1915, 3013) have made a quantitative investigation of the catalytic influence of ultra violet rays on the simultaneously occurring ozone decomposition and the water formation. The experimental method which permits the action of ultra violet rays from a quartz lamp to act on mixtures of hydrogen and ozonized oxygen in variable proportions, is described. The radiations had to pass through so long a layer of gas that, even with small ozone concentration, all the effective light was absorbed. By the measurement of the volume change of the illuminated gas, and by chemical analysis of the gas both before and after radiation, the extent of the participation of the water formation and the ozone decomposition in the photochemical process has been ascertained. It has been found that in the dark no appreciable reaction between hydrogen and ozone takes place within an hour. During radiation the following processes occur simultaneously: (1) $2\ O_3 = 3\ O_2$ and (2) $H_2 + O_3 = H_2O + O_2$. The formation of hydrogen peroxide has not been observed. From a graphical consideration of the change in volume which occurs when the contents of the reaction vessel are subjected to radiation, it is found that with a large excess of hydrogen the contraction associated with water formation occurs, while with large ozone excess the dilation associated with ozone decomposition takes place. At the transition point, out of every three oxygen molecules, two decompose in accordance with equation (1) and one in accordance with equation (2). The photochemical decomposition of ozone is a relatively slower process in the presence of hydrogen. It is however, greatly accelerated by the presence of small quantities of hydrogen but then within a large ozone interval proceeds proportionately to the ozone concentration and above 8% of hydrogen is independent of the hydrogen concentration. From the deviations of the curves from a straight line at the beginning and the end, it has been calculated that the "order" of the ozone decomposition is greater than one in experiments with a large hydrogen excess, and less than one in experiments with a large oxygen excess. It has been shown that the effect of two simultaneously occurring photochemical reactions cannot be regarded as the sum of the effects of the individual processes. In the presence of smaller ozone concentrations, the photochemical water formation proceeds proportionately to those concentrations but approximates a limiting value at higher ozone concentrations, this value being higher the greater the partial pressure of the hydrogen. With constant ozone concentration the water formation is approximately proportional to the hydrogen concentration. With about 100-fold hydrogen excess over the quantity which is necessary for the formation of water in accordance with equation (2), only this reaction takes place.

Effects of Different Wave Lengths.

According to Kowalski-Wierusz (U. S. patent 1,207,347; J.S.C.I. 1917, 90) distinction must be made between three different zones of ultra violet rays, corresponding to the effects which the rays produce. The first zone, or the initial ultra violet, extends from the visible spectrum to about a wave-length of 3,000 Angstrom units. The radiation which corresponds to the rays of this zone is abundantly emitted by the sun. It is but slightly absorbed by the atmosphere. The photochemical reactions which this radiation produces are exothermic almost without exception. The physiological and biological properties are similar to those of the adjacent blue and violet radiation, but more intense. This radiation exerts almost no destructive action on the lower forms of life, such as bacteria. The second zone comprises the so-called middle ultra violet; and extends from about 3,000 to 2,000 Angstrom units. Only the first part of this zone is found in sunlight. The rays of this zone are strongly absorbed by many substances, and therefore the photochemical effects of this radiation are very intense. There is known a whole series of endothermic chemical reactions which are prolonged at the expense of this radiation. Biologically they are bactericidal and coagulate albumin. Finally, the third zone, the extreme ultra violet, corresponds to wave lengths of about 2,000 to 1,000 Angstrom units. This zone can hardly be technically considered at the present time, because radiation of this kind is completely absorbed by a few centimeters of air.

---

[*] All rights of publication in book form reserved by the authors Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

The middle ultra violet rays may be produced by means of the spark gap, and these radiations between 2,900 and 2,200 Angstrom units are effective for sterilization purposes for the following reasons: The investigations of Henri have shown that the shorter the wave length, the more intense is the bactericidal action of the radiations and other investigations have shown that the calcium ion strongly absorbs the short wave lengths. In consequence of this, rays of less than 2,200 Angstrom units are not to be considered in the sterilization of drinking water, which contains more or less calcium.

The method of Kowalski-Wierusz consists in employing a considerable damping of the spark gap, as high a current amplitude as possible, and a wave length of less than 3,000 meters for the oscillation creating the sparks. The damping is obtained by the use of a material for the electrodes which emits ultra violet rays in this sphere. Nickel, cobalt, and alloys of these two metals may be used with other metals and especially with the metals of the rare earths. Moreover, zirconium, tungsten and molybdenum may be employed when the discharge takes place in an inert gas such as hydrogen or nitrogen; a jet of gas may also be injected into the spark gap to increase the spark decrement.

By experiment, it has been shown that the number of spectral lights is not only dependent on the capacity and self-induction used but also on all the electrical conditions of the oscillating circuit and, as regards the radiant energy of different parts of the ultra violet being influenced in a different manner by suitable conditions of the circuit. A series of tests demonstrated that with the increase of the maximum amplitude of current in the oscillation circuit the zone which corresponds to the maximum of radiant energy is displaced toward the shorter wave lengths.

In spark gaps, in which the so-called spark damping is greater, the wave length which corresponds to the maximum of radiant energy is shorter than for spark gaps with less damping. This result can be taken as indicating that the maximum radiation of energy is displaced toward short wave lengths if much energy is consumed in the spark gap. With different electrodes the position of the maximum of radiant energy in the spark was dependent upon the electrode material and is different with an alloy of two metals than with the pure metals, the spark damping being greater with certain alloys, as for example, invar, than with the pure metals. In order to obtain a favorable efficiency of radiation in the middle ultra violet, as great as possible amplitude of current must first be obtained in the oscillation. This, however, is dependent upon the capacity, as well as the self-induction of the oscillating circuit, so that the capacity must be as great as possible and the self-induction as small as possible. For an industrial installation it is, however, compulsory, in increasing the capacity, also to increase the self-induction in consequence of the self-induction of the condensers themselves, as well as the connecting wires which are used between the condensers.

In the employment of the rays for sterilization, chemical actions or other purposes, it is in many cases necessary, or at least desirably, to prevent the action of the oxidation of the nitrogen which takes place in the spark gap upon the substances to be treated with the rays. In such cases a film is placed between the spark gap and the substances to be treated which is transparent to ultra violet rays but keeping back the oxides. This may be effected by arranging a casing of quartz glass around the spark gap.

Diphtheria Toxin.

Lowenstein (Vienna Z. exper. Path. Ther. 15, 279, 1914) has concluded that ultra violet light renders diphtheria toxin atoxic. In 40 hours radiation from a quartz mercury vapor lamp 1,000 fatal doses were completely destroyed. The quartz lamp is about 30 times as active as the iron arc. In the concentrations used, radium has no effect on the toxin. The light alteration is deep-seated since the atoxin does not confer immunity but does sensitize. Toxin neutralized by antitoxin appears to form a combination which is slowly dissociated in the animal, resulting in the development of immunity. Over-neutralization of toxin does not change this phenomenon. Immunity thus developed requires 25-50 days. Injecting neutralized toxin confers about 25 per cent. immunity; i.e., 40 neutralized fatal doses injected into a guinea pig protect (after immunity develops) against 10 fatal doses of toxin. The height of the immunity so produced increases with the dose up to a maximum, while increased doses beyond that merely hasten the time of development. Partially neutralized toxin has no better effect than neutralized. The immunity of guinea pigs injected with over-neutralized toxin is greatly increased by an intracutaneous injection of one milligram of toxin.

ENZYMES.

Amylase and Invertase.

Chauchard and *Mazoue* (Comptes. rend., 1911, 152, 1709) have found that both amylase and invertase lose their activity when exposed to ultra violet light at a distance of 12 centimeters from a quartz mercury vapor lamp working at 110 volts. The decrease of the activity is rapid at first, then becomes slower. Amylase is more sensitive to the light than invertase, either alone or when the two enzymes are mixed.

Pepsin, Rennet, Laccase and Other Enzymes.

Agulhon (Comptes. rend., 1911, 398) exposed preparations of diastase and other enzymes in quartz tubes to ultra violet light, the source being a quartz mercury lamp using 2-3 amperes at 110 volts. The tubes were about 15 millimeters in diameter and 1 millimeter thick, and were placed 15-20 centimeters from the source. Tubes of glass of these dimensions were not penetrated by light of a wave length less than 3,022 Angstrom units. Tubes of glass and quartz containing preparations of the same materials were exposed to the light from one-half to six hours, and the relative activity of the contents examined. The activities of sucrase, amylase, emulsion, pepsin, rennet, and catalase were all reduced by the light which permeates quartz but not glass. Laccase and tyrosinase are attacked when their solutions in glycerol, are diluted with water. Peroxydase of malt is rapidly attacked under the same conditions.

Cell Colloids.

Burge, in a discussion of the mode of action of ultra violet radiation in injuring the refracting media of the eye (J. Frank. Inst. 1915, 477), states that the refracting media of the eye, cornea, lens, etc., are composed of cells containing a colloidal material or protein, of which egg-white is a good example. It is known that egg-white is converted into an opaque coagulum on exposure to ultra violet radiation, just as it is when it is heated to 100° C.

Free swimming unicellular organisms, paramecia, were exposed to the radiation from a quartz mercury burner and observed under the microscope during the exposure. The normal organisms are transparent; those exposed become very granular and opaque. The conclusion may be drawn that ultra violet radiation injures or kills living cells by coagulating the protoplasm or living material of the cells.

A normal excised crystalline lens was placed between two quartz plates and pressed into a thin layer by squeezing the plates together. By means of a quartz spectograph the spectrum from a quartz mercury burner was focused on the layer of transparent lens material for 30 hours. At the end of this time it was as transparent as at the beginning of the experiment. However, when the preparation was immersed in 0.1 per cent. calcium chloride solution, four bands of coagulated lens protein appeared where the bands of the spectrum had been focused. These bands are of wave lengths 249, 254, 265 and 280 respectively.

The further conclusion is drawn by Burge that the short wave lengths of the spectrum coagulate the living material of the cells by changing this material in such a way that certain salts (e.g. those of calcium) can combine with it to form a precipitate or coagulum, and that the effective wave lengths in case of the quartz mercury arc used are between 249 and 280 inclusive.

Treatment of Wines.

In discussing methods for artificially ageing wines, *Henri Helbronner* and *von Recklinghausen* (U. S. patent 1,130,400 March 2, 1915) state that the process of producing liquors of this class may be divided into two stages. In the first or fermentation stage, the wine is allowed to ferment in contact with air, while the second or ageing stage takes place in storage in casks or bottles. In this latter stage, the characteristic flavor is produced by the formation of various compounds, mainly ethers. When wine which has passed the fermentation stage is exposed in thin films to the action of ultra violet light, the taste and color of the wine is changed and it quickly attains the characteristics of old wine. The time of treatment is comparatively short, an example being given in which two and one half litres were treated in several minutes in a small apparatus, it being claimed that after this treatment the wine had the characteristics of a product several years older.

Before the war in France, it was reported that the use of ultra violet light for ageing wine was making substantial headway there and that it promised to modify the manufacture of this commodity in a highly advantageous manner. No information is at hand regarding the present status in that country.

The action of ultra violet rays on the alcoholic fermentation of India fig has been studied by *Romolo* and *De Fazi* (Ann. chim applicata 6, 221, 1916, Chem. Abs. 1917, 683). If the period of exposure to the rays be limited, saccharomyces opunitiae lives, reproduces itself, and is more vigorous than under normal conditions. Too long an action, however, is harmful, and the activity of the organism gradually decreases, and may be killed by the rays after many hours' exposure Must of India fig in ordinary fermentation forms an abundant film on the surface which increases in thickness from day to day, but if the fermentation takes place under the ultra violet rays, no trace of film is visible, even after many days.

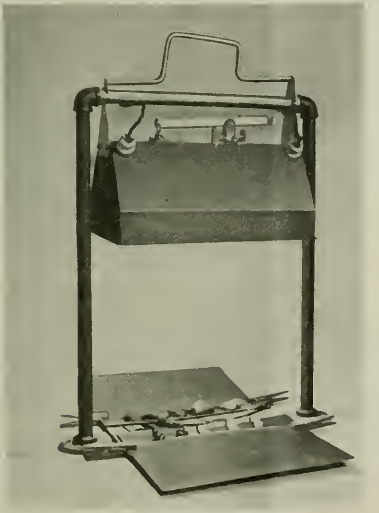
On red wines, ultra violet light has a pronounced bleaching effect. Grape-juice (red) rapidly loses its color on exposure to a source of strong ultra violet light.

Low Grade Flour.

In the writers' laboratory, samples of low-grade flour or midlings have been considerably bleached after an exposure of eight hours at about six inches from the lamp to the action of ultra violet light. The change is too slow to offer commercial possibilities.

Soluble Starch.

Massol (Comptes. rend. 1911, *152*, 902) states that if solutions of soluble starch (prepared by heating for 3 hours at 150°C.) of 0.2 to 1 per cent. concentration, are exposed, at a distance of 10 centimeters, to the action of a mercury vapor quartz lamp consuming 300 watts, the starch gradually loses the property of giving a blue color with iodine, the color undergoing an alteration similar to that observed when the iodine test is applied at various stages of starch conversion. The rate of transformation increases on decreasing the concentration and on acidifying the medium. As a result of the exposure also, the solution acquires reducing power and becomes less precipitable by alcohol; the portion soluble in alcohol possesses reducing power and is dextro-rotatory. Examination of the product obtained on exposing a solution containing 1.7 grams of soluble starch and 1.715 grams of sulphuric acid per 1,000 cubic centimeters to ultra violet rays showed that the reducing substance formed is probably maltose. A control experiment in which the solution, instead of being exposed to ultra violet rays, was heated to 72°C., showed that neither the acidity nor the temperature conditions are capable under the conditions of Massol's experiment, of effecting the transformation and the latter is therefore due to photochemical action.



Ultra Violet Color Tester.
(Courtesy of the R. U. V. Co., Inc.)

Testing of Dyes.

Scheurer (Bull. soc. ind. Mulhouse 1911, 80, 324) has compared the action of sunlight with ultra violet light produced by the mercury quartz arc on dyes When using ultra violet light the dyes were protected against the ozone formed. Benzo colors were hardly faded by sunlight, but in 24 hours by the mercury quartz arc they were materially changed. Indigo resisted mercury quartz arc light better than it did sunlight.

The R. U. V. Company* (private communication) have developed a laboratory apparatus for the testing of dyes for light fastness by means of ultra violet light. They state that there is no color which ultra violet rays will not fade and that there is little difference in the actual fading qualities of the colors if the matter of the depth of color is eliminated A large number of colors have been tested but details of these tests are not available at this time.

Gebhard (Farber-Ztg. 1911, 22, 6, 26) suggests that the present method of testing fastness of colors with daylight is unsatisfactory, due to varying atmospheric conditions and proposes using a cabinet with both an enclosed arc and a mercury quartz arc. The change of color whether fading or change to another tint is to be recorded by orthochromatic photography using a light filter of the same color as the original dyeings.

Absorption of Ultra Violet Light.

The absorption of ultra violet radiations by several chlorides of ethane, ethylene and acetylene has been investigated by *Massol* and *Faucon* (Compt. Rend. 1917, 308-10). None of the compounds studied showed the characteristic band of chlorine. Tetrachlorethylene absorbs more ultra violet radiations than hexachlorethane or acetylene tetrachloride. This difference in absorption is attributed to the difference in the saturation of the molecule.

Bielecki and *Henri,* (Chem. Zeit. Rep. 1914, 16; Ber. 1913, 3650) have made a study of the absorption of the ultra violet rays by saturated and unsaturated fatty acids. The results are given in a tabulated form and also in curves. The position of the double bond as related to the carboxyl group appears to be the deciding factor. The nearer the double bond is to the carboxyl group the greater the influence on the absorption. The cis form absorbs less than the trans form. The effects produced in various solvents were also studied.

Massol and *Faucon* (Bull. Soc. Chim., 1912, 11, 931-935) have made determinations on the absorption of ultra violet light by saturated fatty alcohols by means of a quartz spectograph. The light was supplied by an electric arc between a brass terminal and an iron one covered with an alloy of tin, lead and cadmium. Impressions on a photographic plate were obtained of wave lengths lying between 5,015 (green) and 2,100 Angstrom units. The liquids were enclosed in a glass vessel with quartz ends. The thicknesses were varied between one and one hundred millimeters. Methyl and ethyl alcohols proved very transparent. The transparency diminishes slowly with an increase of the thickness. With other normal alcohols such as butylic, amylic, hexylic, heptylic and melissic, the absorption increases very rapidly with the thickness. The transparency diminishes with the increase of the number of carbon atoms. The secondary alcohols behave in much the same way as the primary alcohols, but a secondary alcohol is slightly more transparent than the corresponding primary one. Tertiary alcohols are much more transparent for the same thicknesses. Methylpropanol, methylbutanol- 1.2 (optically active), and methylbutanol 1.3 (optically inactive) are less transparent than the corresponding primary alcohols. They show, with thicknesses of less than ten millimeters two absorption bands, one at the wave length of 2,500-2,600, the other at the wave length of 3,100 Angstrom units. These bands disappear when the thickness is increased above ten millimeters, because at that point all waves of a length less than 3,100 units are absorbed.

---

*50 Broad St., N. Y.

In a discussion of the liberation of point discharges by ultra violet light *Ferlach* and *Meyer* (Verh. deut. physik. Ges. 15, 1037, 1914) state that for both positively and negatively charged points in air the delay of the beginning of the discharge caused by exposure to ultra violet light decreased with decreasing pressure of air. This delay has only a secondary bearing on the photoelectrical effect. At the relatively low pressures employed the delay effect decreased with increasing intensity of illumination.

Nuclei Produced by Ultra Violet Light.

From experimental investigation with gases and vapors in a Wilson expansion apparatus the following conclusions were drawn by *Saltmarsh* (Proc Phys. Soc. London 27, 357, 1915). Nuclei produced in air by ultra violet light which has traversed a few centimeters of air are not affected by an electric field of 50 volts per centimeter. The nuclei are equally effective in producing condensation of water, toluene and turpentine vapors, and they are formed even by light which has traversed 50 centimeters of air. Alcohol vapor condenses without expansion on much smaller nuclei than water. No nuclei were formed by light in absence of oxygen or carbon dioxide. There was no trace of hydrogen peroxide in the clouds on nuclei. Oxygen containing ozone also contains nuclei for condensation having similar properties to those formed by ultra violet light. The nuclei can be destroyed by heating. It seems probable that the nuclei formed by ultra violet light do not cause condensation by virtue of any particular chemical change, but that they are particles large enough to act like dust particles as centers round which condensation can begin.

Photochemical Experiments of Baudisch and Furst.

Baudisch and *Furst* (Ber. 1912, *45*, 3426) have arrived at the following conclusions as the result of photochemical experiments. The change produced by light on the ammonium salt of alpha-nitrosonaphthyihydroxylamine is due to the action of violet and blue rays of comparatively long wave length which will pass through glass and other substances. If a piece of stout filter-paper be treated with the above salt, steamed, and exposed to the rays from a quartz mercury vapor lamp with a glass plate covering half of the sheet, it is found that the paper is uniformly reddened. The same result is obtained by using a gelatin plate or a solution of a starch or albumin. If, however, the filter paper is treated with a solution containing potassium nitrate or potassium iodide and starch and illuminated in the same way, it will be found to turn blue only where it is uncovered. The rays which cause the evolution of oxygen from potassium nitrate are of short wave length and are absorbed by various filters. It is suggested that the colloids of plant cells can exercise a similar differentiating influence on the radiation which they receive. From the above ammonium salt, free alpha-nitrosonaphthyhydroxylamine can easily be obtained by precipitation with metaphosphoric acid. It is soluble in chloroform but the solution gradually changes owing to the reducing action of the chloroform, which forms a-diazonaphthalene chloride.

Chlorination of Coal Gas.

To ascertain the possibility of using coal gas for the production of valuable compounds, *Bedford* (J. Ind. Eng. Chem. 1916, 1090) subjected a mixture of chlorine and natural gas, in a chamber containing blocks of ice, to the action of light from the white flame arc and obtained a heavy liquid beneath the water produced by the melting of the ice. This liquid consisted of methylene chloride, 35%; chloroform, 35%; carbon tetrachloride, 5%, and chloroethanes, 20%. A portion of the product, amounting to about 14% of the total, remained soluble in the water, and consisted of methylene chloride, 61%; chloroform, 28%; carbon tetrachloride, 1.5%, and chloroethanes, 6%.

Determination of Shells in Cocoa.

A method for the detection of shells in cocoa is described by *Wasicky* and *Wimmer* (N. Nahr Genussm. 30, 25-7, 1915). This method is based upon the difference in appearance between shell and nib tissue when viewed through a microscope by ultra violet light. The proper light is best obtained by means of a carbon-iron arc lamp, the light before reaching the mount being passed through a Wood-Lehmann filter (two blue Uviol glass cells, one filled with 1:12000 nitrosodimethylaniline, and the other with concentrated copper sulphate solution The color of the shell tissues when seen by this light is buff or brown, the mucilage cells being almost colorless or a light yellowish green. The nib tissues appear in various shades of blue-violet. The details of the method are as follows: Treat ten milligrams of the powder with ten cubic centimeters of alcohol-glycerol mixture (equal parts of each) and allow to stand for one hour. Centrifuge, pour off the liquid layer and add one cubic centimeter of borax-glycerol solution (1 gram borax, 15 grams glycerol) to the solid residue. Mix thoroughly and place one drop upon a Hartwich-Wichmann counting cell. View through a microscope by means of ultra violet light and count the number of shell particles visible over a given area. The per cent. of shells present can be ascertained by counting the shell particles in mounts of known composition prepared in the same way and comparing with the count of the unknown. The samples employed for comparison must have about the same degree of fineness.

Celluloid Substitute.

According to *Kuhl* (Reports of the Progress of Applied Chemistry issued by the Society of Chemical Industry, Vol. 1, 1916, 192 J.S.C.I. 1915, 623) the polymerization of vinyl esters (vinyl acetate or vinyl chloracetate) by ultra violet light yields solid masses which may serve as substitutes for celluloid and which are fireproof and odorless. The polymerization is assisted by catalytic agents (organic peroxides) to give thick syrups which on illumination give solid masses having valuable properties.

Vulcanization of Rubber.

Bernstein comments on the use of ultra violet light for the vulcanization of rubber (U. S. patent 1,240,116, September 11, 1917, as follows: Vulcanization by heat requires a considerable plant; the operation is a lengthy one, and does not permit the incorporation of compounds or substances which are decomposed by heat, such as for instance, leather and coloring matter. The use of sulphur chloride produces noxious effects upon the workmen, gives irregular results and does not allow chloride of sulphur such as, for example, lead oxide, lead carbonate, zinc oxide, etc. These various disadvantages are claimed to be avoided by exposure of the rubber mixed with sulphur, sulfids or other vulcanizing agents to the action of ultra violet rays by this process. Vulcanization can be hastened by the application of heat and pressure. In this case it is claimed to be unnecessary to utilize high temperatures, 65° C. to 80° C. being sufficient. The temperature depends upon the nature of the gum, viz: upon its degree of polymerization. The object in applying pressure is not only to hasten the vulcanization but also to prevent the formation of blisters upon the surface of the vulcanized compound. These blisters result from the expansion of air introduced into the compound during the process of manufacture and from the traces of moisture previously absorbed by the gum. In vulcanization by means of hot air it is necessary to incorporate accelerators in the mixture, such as lead oxide or magnesia, etc. In the case of photo chemical rays, however, the employment of these accelerators is claimed to be unnecessary, the superficial vulcanization progressing spontaneously toward the inner portion of the object under treatment so that the vulcanization becomes complete. The action of the photo-chemical rays appears to be catalytic in nature. The surface vulcanized by means of ultra violet rays protects the subjacent substance from any secondary reaction such as, for instance, its resinification. In order to avoid the formation of ozone produced by the action of the ultra violet rays the operation may be carried out in *vacuo* or in an atmosphere consisting of a neutral gas not containing oxygen. The time required for the vulcanizing process will depend upon the nature of the gum employed, the distance of the lamp or lamps from the surface under treatment, the nature of the substance and the power of the lamp or lamps.

A widely circulated newspaper report appearing some years ago stated that a man by the name of Blanco had exploded a case of dynamite at a distance of half a mile with an ultra violet ray apparatus. Blanco claimed that magazines of ships and gasoline tanks could be exploded by this means. This sensational report apparently has received no confirmation from reliable sources.

Photographic Effects.

Wood (Scientific American Nov. 15, 1913, 380) gives the results of experiments in photographing various objects by means of the ultra violet and infra red rays. With the ultra violet light a difference is shown in the quality of white in various white flowers. Photographs of the craters on the moon show new characteristics with ultra violet light. The vapors rising from a drop of mercury are easily visible when photographed by this method. It is also easy to determine erasures and changes in checks and legal documents which are invisible in ordinary light. The best ink eradicators show a dark smudge when they have been applied. Various screens and types of apparatus are described.

As an Illuminant for Photographic Purposes.

Mees (J. Frank. Inst. 180, 481, 1915; Chem. Abs 1915, 3180) recommends the following artificial illuminants for use in practical photography: For portraiture, flame arcs, Cooper-Hewitt lamps, and the nitrogen tungsten lamp; for motion pictures, the Cooper-Hewitt lamp, quartz arc, flame arc; for photo engraving and silver printing, flame arc, enclosed arc; for platinum printing, the Cooper-Hewitt lamp.

Transparency of Metal Solutions.

The ultra violet transparency of certain colored media is described by *Absalom* (Chem. Abs. 1917, 2556, Phil. Mag. 1917, 450) who states that many gems and minerals which are transparent in ultra violet light when colorless, do not lose their transparency in the colored specimens, nor is any effect noted on artificially coloring a specimen by means of cathode rays, although colored metallic salts and aniline dyes are opaque. This is strong evidence that the color of minerals is due to colloidal metals, especially in such cases as hyacinth (zircon) and yellow topaz which only begin to be opaque at 2617 and 2294 respectively Deeply colored solutions of the alkali metals and magnesium in liquid ammonia also are extremely transparent in the ultra violet, which tends to show that these metallic solutions are colloidal.

Comminution of Metals.

Schulze (Ber. physik. Ges., 1912, 246-57) states that experiments on the conversion of metals into dust by means of ultra violet light have negative results. Three different methods were tried.

Active and Passive Iron.

Allen (Faraday Soc., Nov. 12, 1913) states that iron which is chemically active shows a relatively large photoelectric activity, as it loses a negative charge fairly rapidly when insulated and illuminated by ultra violet light. Processes which render the iron passive greatly reduce this activity. These facts are in good agreement with the theory that the cause of passivity is to be found in the presence of a gaseous layer on the metallic surface. This theory, like the oxide film theory, was originally put forward by Faraday.

Peculiar Properties of Zinc.

Anderson and *Morrison* (Phil. Mag., 1912, *24*, 302) have stated that the surface of a metal, whether from oxidation or from some other cause, changes with lapse of time so as to make the metal more electronegative. For example the contact difference relative to a plate of uncleaned copper was 0.060 volt for freshly cleaned copper, 0.466 volt for uncleaned zinc, and 0.826 volt for freshly cleaned zinc. It has now been found that when exposed to a powerful source of ultra violet light, zinc becomes decidedly more electro-negative, the effect disappearing slowly when the source of light is removed.

Salts of Mercury.

Pougnet (Comptes. rend., 1915, 161, 348-351, J. S. C. I. 1915, 1053) exposed a 5% solution of mercuric chloride in a quartz tube 15 centimeters from a mercury vapor lamp working under 110 volts and 4 amperes. Almost immediately it became cloudy, owing to formation of calomel. After 30 minutes, 42% of the mercuric cloride had been decomposed and the calomel began to darken. After about 70 minutes when 48% of mercuric chloride had been decomposed, the reaction ceased. The reaction is reversible, one gram of calomel suspended in water and agitated during exposure yielding 0.635 grams of mercuric chloride in 6 hours; the action, slow at first, was accelerated as the suspended particles became finer. Most of the salts of mercury, especially when moist, are decomposed by ultra violet rays, and it is therefore advisable to keep them in bottles of orange-red color.

Formation of Perchlorates.

A process for the electrolytic formation of perchlorates is described by *Mack* (J. Phys. Chem 1917, 238), in which he states that chlorate may be oxidized to perchlorate in an acid solution by the use of sulphuric acid, ozone, and hydrogen peroxide. But when hydrogen peroxide is used hydrochloric acid is produced and interferes with the oxidation. The reaction may be carried out with oxygen if activated by the use of ultra violet light. The electrochemical formation of perchlorate is due to direct oxidation and the formation of the perchlorate at a potential far below that required for the continuous discharge of any ion present in the solution.

If chlorine gas is subjected to the silent electric discharge in a manner similar to that used in the preparation of ozone, a chemically active form of chlorine is obtained. The activity of this element is even greater than if subjected to the silent electric discharge and ultra violet light simultaneously. It has been supposed that under the influence of the electric discharge the chlorine forms a body analogous to ozone. It is, therefore, thought that the activity of the chlorine treated in this way depends simply on impurities such as air and water, as a result of which ozone or unstable chlorine oxide is formed. (Abderhalden, Handbuch der Biochemischen Arbeitsmethoden, Vol. IV., 870.)

Sulphur Oxychloride.

Trautz (Z. Elektrochem. 21, 329, 1915; Chem. Abs. 1915, 3008) states that the reaction $SO_2 + Cl_2 = SO_2Cl_2$ in the dark cannot be considered as a pure gaseous reaction. Only on the addition of animal charcoal as a catalyzer were easily reproducible velocity measurements obtained; then both reactions proceeded as absorption processes in which the velocity of diffusion did not appreciably interfere. In both cases the reaction is approximately normal, though more so in the decomposition than in the formation of the oxychloride. In the latter case the reaction constants decreased more rapidly, corresponding to a lower order of reaction (absorption). The temperature coefficient of formation is about 1, that of the decomposition about 1.5, though both values are too small on account of the slower temperature effect of absorption. The formation of the oxychloride from sulphur dioxide and chlorine in glass vessels under the light of a quartz lamp at 291° and at various concentrations has been studied. The reaction especially at the higher temperature proceeds smoothly as a second order reaction; the constants at the higher temperature are without variation. In the light, sulphuric oxychloride is not the only product of the reaction; if the relatively small periods of illumination are separated by several hours of darkness, other substances are formed which cause a decrease in the velocity constant of the reaction. When continuous illumination was employed, constants were no longer obtained, probably on account of the other products of the reaction. A temperature increase of 80° decreased the velocity of formation corresponding to a temperature coefficient of 0.88 for each 10°. The velocity of the formation-reaction is of the same order as that which is catalyzed by animal charcoal in the dark, whether "Uviol" light or that from a quartz lamp is used. The formation of sulphuric oxybromide from sulphur dioxide and bromide in the light of a Nernst lamp or in the dark, between 106° and 202° in glass vessels without a catalyzer, could not be accomplished. But carbon oxybromide could be readily formed from carbon monoxide and bromine vapor, an equilibrium being quickly reached which corresponded to a very large dissociation of the carbon oxybromide. From the equilibrium constants at 73° and 181° the heat of formation was calculated as about 3,000 cal.

(To be continued in the January issue.)

New Publications of the Bureau of Mines

(*List* 54.—*November*, 1917.)

Bulletins.

Bulletin 131. Approved electric lamps for miners, by H. H. Clark and L. C. Ilsley. 1917. 59 pp., 17 pls., 7 figs.

Bulletin 136. Deterioration in the heating value of coal during storage, by H. C. Porter and F. K. Ovitz. 1917. 38 pp., 7 pls.

Bulletin 141. Yearbook of the Bureau of Mines, 1916, by Van H. Manning. 1917. 173 pp., 17 pls., 8 figs.

Technical Papers.

Technical paper 167. Men who received Bureau of Mines certificates of mine rescue training, July 1, 1914, to June 30, 1916, compiled by D. J. Parker. 1917. 66 pp.

Technical paper 173. Coke-oven accidents in the United States during the calendar year 1916, compiled by A. H. Fay. 1917. 19 pp.

Technical paper 175. Production of explosives in the United States during the calendar year 1916, compiled by A. H. Fay. 1917. 24 pp.

Handbook.

Advanced first-aid instructions for miners; a report on standardization, by C. H. Halberstadt, A. F. Knoeffel, W. A. Lynott, W. S. Rountree, and W. J. Shields. 1917. 154 pp., 65 figs.

Note.—Only a limited supply of these publications is available for free distribution and applicants are asked to co-operate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers cannot be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

Aetna Explosives Co. Has Disastrous Explosion.

The plant of the Aetna Explosives Co. at Heidelberg, devoted to the production of trinitro-toluene, was wrecked by an explosion on December 5. Eight lives were lost and there were twenty-five injured. The explosion occurred in the drying department, in one of the eight 48,000-gallon tanks in which the explosive was being made. Losses exceeded $250,000. Windows were shattered throughout a section radiating 2 miles from the plant.

U. S. Bureau of Chemistry Wants Men

The Department of Agriculture is planning to conduct a special campaign to prevent grain dust explosions and fires in grain mills and elevators. For this work men are wanted with milling, mechanical or electrical engineering training and experience. (Salaries $1,440 to $1,800 per annum.)

Investigations will extend throughout the U. S., traveling expenses and subsistence will be provided. Those interested should address C. L. Alsberg, Chief, Bureau of Chemistry, Department of Agriculture, Washington, D. C.

Secretary Lane Names Six Chemists to Serve on New War Board

Because of the great amount of war work being done by the Bureau of Mines, Secretary of the Interior Lane has appointed six of the prominent chemists of the country to act as an advisory board to the bureau.

The members of this board are: Dr. Wm. H. Nichols, General Chemical Company, New York, chairman of the board; Prof. H. P. Talbot, head of the chemical department of Massachusetts Institute of Technology, Boston, Mass.; William Hoskins, consulting chemist, Chicago, Ill.; Prof. H. P. Venable, head of the chemistry department, North Carolina University, Chapel Hill, N. C.; E. C. Franklin, professor of chemistry, Leland Stanford University, Stanford, Cal.; and Dr. Charles L. Parsons, chief chemist of the Bureau of Mines.

The board will discuss and advise upon gas warfare research, the minerals especially needed for munitions, and the recently enacted law for the regulation of explosives.

Bureau of Mines to Enforce New Explosives Law.

Washington, November 11.—Any person in the United States found with explosives in his possession after November 15, and who does not have a license issued by the Federal Government showing the purpose for which the explosives are to be used, will be at once arrested and fined up to $5,000 or sent to prison for one year. If the circumstances warrant, the person may be fined $5,000 and in addition given the one year in prison.

Peabody to Assist Director Manning.

This is the principal clause in a war measure passed by the last Congress which is now being put into effect by the Bureau of Mines, Department of the Interior, which bureau has been charged with its enforcement. Francis S. Peabody of Chicago, a well known coal operator familiar with the use of explosives, large amounts of which are used in the coal mining industry, has been appointed by Secretary of the Interior Lane to act as assistant to the Director of the Bureau of Mines, Van H. Manning, in the enforcement of the law. Under the law, the director of the bureau is empowered to utilize the services of all United States officers and all police officers of the states, including the city police forces, county sheriffs, deputies, constables, and all officers in any way charged with police duties. The police of the cities have already been organized for this work, headed by a committee of chiefs of police in the big cities, of which Major R. W. Pullman, superintendent of police of Washington, D. C., is chairman. The police are not only to look after the enforcement of the law, but are also to make thorough investigations of all dynamite outrages and fires in factories and warehouses, and to make their reports to the Director of the Bureau of Mines.

Law Affects Possessors of Explosives.

Persons apprehended in plots to blow up factories and bridges will be turned over to the authorities for prosecution under Federal or state laws. Most states have specially severe punishments for these crimes. New York has an extreme penalty of twenty-five years' imprisonment for the placing of dynamite with intent to blow up property. The penalty provided in this Federal war measure is merely to cover the illegal possession of explosives.

The law provides that everyone who handles explosives must have a license. The manufacturer, the importer and the exporter must have licenses issued by the Bureau of Mines in Washington. The seller of explosives and the purchaser of explosives must also have licenses, these to be issued generally by county clerks, or other local officers who are authorized to administer oaths. There will be at least one licensing officer in each county, and more agents will be designated if the county is sufficiently large to warrant it. If a state has laws providing for a system of licensing persons manufacturing, storing, selling or using explosives, the state officials authorized to issue such state licenses shall be designated as Federal licensing agents; also city officials qualified to issue city explosives licenses will be given authority to issue Federal licenses. A Federal license will not relieve any person from securing licenses required under state laws and local ordinances.

In each state there will be appointed a state explosives inspector, who will represent the Bureau of Mines in the administration of the law within the state.

Only citizens of the United States or of countries friendly to the United States and the Allies may so obtain licenses.

Contractors, mining companies, quarrymen and others using large quantities of explosives, which are handled by employees, may issue explosives to their employees only through those employees holding a license, called a foreman's license.

The purchaser of dynamite, in obtaining a license, must state definitely what the explosive is to be used for and will be held accountable for its use as stated and the return of any explosives that may be left.

With the strict enforcement of this law, the Federal authorities hope to prevent explosives falling into the hands of evilly-disposed persons and to put a stop to all further dynamite plots.

British Exports of Dyestuffs.

It is rather astonishing that Great Britain, despite the difficulty of adequately meeting the requirements of her own dyers, should still be able to ship abroad considerable quantities of both natural and artifical dyestuffs. And yet she is doing this regularly and in increasing amounts. The detailed reports show that during 1916, coal-tar colors were exported to the extent of 3,225 short tons, valued at $3,298,000. Similar exports for 1917 were 2,017 tons, valued at $1,311,000. Switzerland was the chief purchaser, taking 1,348 tons—probably aniline or intermediates. British possessions took 996 tons and the United States 370 tons.

Natural dyestuffs were exported to the extent of 6,755 short tons, valued at $2,046,000. In 1915 the exports were 9,460 tons. Russia, Australia, Canada, the United States and Portugal—in the order named—were the trading purchasers.

Examination of Pigments.

Several recent contributions to the methods of testing pigments are of value in connection with the manufacture of lakes from coal-tar compounds. The most important are the following:

Physical Characteristics of Pigments and Paints, H. A. Gardner, Oil & Col. Tr. J., 1917, *51*, 1054.

Physical Properties of Pigments which Affect the Permanency and Efficiency of Paint Coatings, M. McNaughton, Paint, Oil & Drug Rev., 1917, *63*, No. 24, 6.

Use of the Flame Arc in Paint and Dye-Testing, W. R. Mott. Reprint of a paper read at the 28th general meeting of the American Electrical Association, San Francisco. Application may be made to Joseph W. Richards, South Bethlehem, Pa. This article contains many references to the literature on the subject.

Eimer & Amend Erecting New Home.

Eimer & Amend, 211 Third avenue, New York, manufacturers of chemicals and apparatus, have acquired a factory building at 13-17 Margaretta street, Newark, N. J., and are planning for extensive alterations and improvements. This company is also erecting a new building on Third avenue, between 18th and 19th street, New York, which will cost about $150,000.

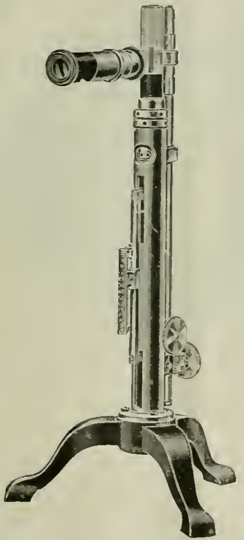
Synthetic Tanning Agents, M. Wade, London, (British patent 18,174, of 1915) prepared different synthetic tanning substances by condensing formaldehyde, or substances yielding it, with amino-naphthol-sulfonic acids, dioxynaphthalene-sulfonic acids or mixtures thereof, in aqueous or slightly acid solution, at ordinary or raised temperatures. The products can be used alone or with other tanning materials,

NEW APPARATUS

Conducted by F. W. S.

From month to month the newest forms of apparatus of interest to chemists and chemical engineers will be described and illustrated in this department. Information as to where various articles can be purchased may be obtained by addressing The Chemical Engineer, 118 East Twenty-eighth Street, New York City.

Specific Gravity Apparatus for Diamonds and Precious Stones



New Form of Apparatus for Specific Gravity Determinations.

The apparatus illustrated below is used for determining the specific gravity of diamonds and other precious stones, as well as so-called "Black Diamonds" and various crystals, minerals, etc. It consists of a metal stand with an arrangement provided at the top for moving a metal rod up and down. The exact position of the metal rod at any instant is shown by a scale at the side.

The metal rod is of an exact diameter, so as to occupy a definite space. The rod moves up and down in packing which is of liquid type. Surrounding the upper part of the rod is a glass tube which is also liquid type at the bottom. The small telescope shown at the top of the instrument is provided with cross hairs for exactly determining the position of the meniscus of the liquid.

To operate the apparatus the glass tube is filled with any desired liquid, in most cases, alcohol, to a definite point as determined by the telescope. The sample to be tested is then placed in the solution. The central rod is next lowered by means of a screw at the side until the meniscus stands again at exactly the same level as before, as determined by the telescope. The exact space occupied is then read on the scale at the side with the help of the Vernier, as designed by Professor Meade, of the University of Wisconsin. This space, divided by the weight in grams, gives the specific gravity of the sample.

A New Safety Crystal Which Cracks But Does Not Break

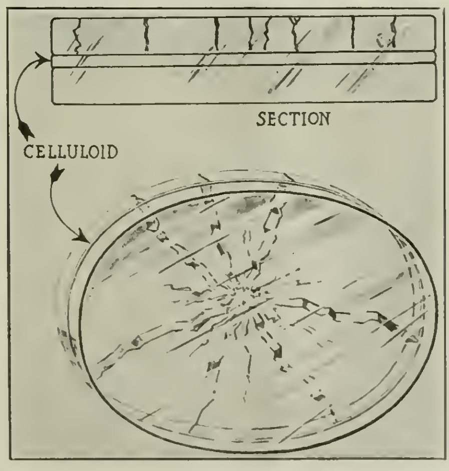


Diagram of Cross Section Illustrating the Construction of New Safety Crystal.

Of interest to the chemical engineer quite as much as to the practical workman or chemist is a new safety glass which has been developed by a New York firm and which bids fair to have a wide application in connection with industrial masks and goggles used for protective purposes to shield the eyes of the workman from flying particles, dust, heat or injurious gases.

The big feature of this new glass is the fact that while it can be cracked, it cannot be broken, even with a hammer blow, while in cracking there is no flying of splinters to jeopardize the eyesight of the workman. The fact that even when cracked the glass remains perfectly gas and water tight goes a long way toward

Government Paper on Specifications for Motor Gasoline

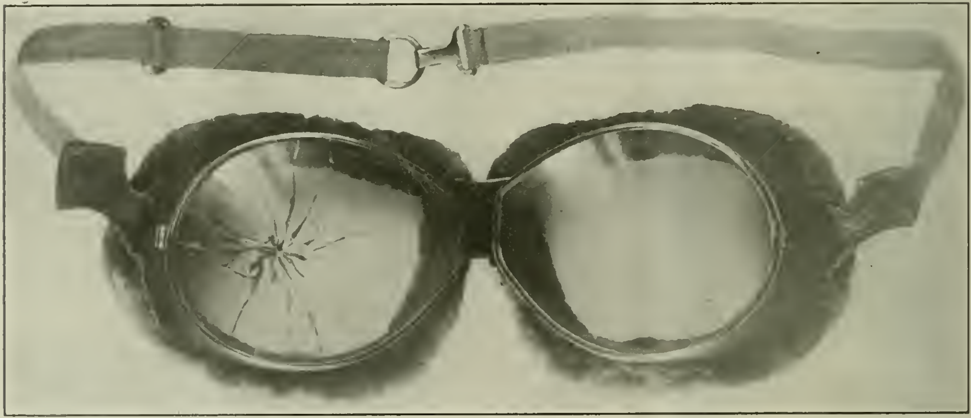
Responding to the many demands from state and municipal legislative bodies regarding specifications for the regulation of the quality of gasoline, the Bureau of Mines, Department of the Interior, has issued Technical Paper 166, "Motor Gasoline; Properties, Laboratory Methods of Testing and Practical Specifications," by E. W. Dean.

The paper gives information obtained by the bureau in the course of its investigations dealing with gasoline and aims to aid technical men representing producers and consumers of motor fuel in establishing convenient and satisfactory methods of testing and in interpreting analytical results in a practical way.

The present gasoline situation is confused by the existence of contradictory views as to the true index of quality of motor fuel. These views vary all the way from belief that a simple gravity test furnishes an adequate index of quality to claims that there is no practical test of gasoline except that of actual use Confusion also exists because of the variety of types of gasoline now sold and there are disputes as to the relative desirability of products derived from different types of crude oil and through different processes of refining. In some instances gasolines are condemned on account of properties that do no harm and in other cases high ratings are given products actually of low grade Adequate methods of analysis, though simple, are of fairly recent development and are not satisfactorily described in the literature. In addition there is more or less vagueness about the proper way of interpreting results even when the method of analysis has been satisfactory. The present paper does not pretend to be absolutely comprehensive or highly scientific, but treats in a practical way the problems and difficulties just mentioned.

Laboratory methods for the distillation of gasoline are discussed in detail and reasons given for the choice of the method adopted. This is practically the same as that recommended by the American Society for Testing Materials, in connection with the analysis of turpentine substitutes. The method is simple and rapid and is already in more or less general use.

A typical set of specifications is furnished, omitting, however, definite temperature limits, which should be decided upon only after consideration of local conditions. Methods of analysis, particularly of distillation, are described in detail.



Coggles Showing One of the New Crystals Cracked Without Splintering of the Glass.

New Safety Crystal

(Concluded from page 75)

recommending its use in place of the ordinary glass crystal, for it lends an added element of safety.

"Resistal" is the trade name of the glass used in the manufacture of these safety goggles and masks and its construction is made plain by the accompanying sketch. It comprises two layers of perfect optical glass which may be either flat or curved, with a layer of celluloid interposed, the whole being welded—not cemented—into a solid mass.

The result is a crystal that has every virtue possessed by the plain glass with none of its dangers or drawbacks; and it has, moreover, the strength and safety features of the celluloid "light," but unlike celluloid, it is absolutely unscratchable, is rigid and perfectly fireproof. Neither is it affected by water, heat or cold and the celluloid acts as a heat-insulating medium between the surfaces effectively preventing "clouding up" due to moisture condensation.

As a testamonial of the worth of the new crystal is the fact that goggles fitted with the safety glasses have been adopted for the needs of the Aviation Corps, U. S. Army, while from the same quarter the makers have received orders for a large number of crystals for military mask manufacture.

FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Saccharine.

25752.—A society in England desires to purchase saccharine. Quotations should be made f. o. b. United States port. Payment will be made by cash against shipping documents. References.

Paints, Colors, Varnishes, Glue.

25778.—An agency is desired by a commission agent in Spain for the sale of paint brushes, paints, varnishes, colors, coloring materials, glue, and enamels. Correspondence should be in Spanish. References.

Dyestuffs.

25712.—An agency is desired by a man in France for the sale of dyestuffs. Goods should be packed in cases or casks. Samples and price lists should be submitted. Correspondence should be in French. References.

Caustic Soda, Aniline Oil, Acetic Acid.

25707.—A firm in England is in the market for caustic soda, all chemicals such as glacial acetic acid, etc., aniline oil, and antimony, put up in 1-hundredweight casks or drums. Quotations should be made f. o. b. New York. Payment will be made by cash in the United States. Reference.

Dyestuffs and Tanning Products.

25698.—A firm in France desires to purchase or secure an agency for the sale of chemical products, dyestuffs, tanning products, petroleum, and oils. Payment will be made against documents. Correspondence should be in French. Reference.

Copper Sulphate and Sulphur.

25552.—A company in Portugal wishes to secure an agency for the sale of sulphate of copper, pure 99 per cent, sulphur in bags or bulk, and rough chemicals in general. Quotations should be made f. o. b. New York. Confirmed credit will be opened by cablegram. Correspondence should be in French. Reference.

Explosives, Dyes and Tanning Materials.

25557.—An agency is desired by a man in Peru for the sale of textiles, chemicals, explosives, dyes, and tanners' supplies and machinery. Payment will be made by draft against documents, sight or 90 days. Correspondence should be in Spanish. References.

Glycerine.

25484.—A merchant in Algeria desires to buy five or ten thousand kilos of glycerine at 30°. Correspondence should be in French. References.

Copper Sulphate.

25431.—A man in Switzerland is in the market for a large amount of sulphate of copper. Correspondence in French preferably. References.

Ammonium Chloride, Ammonium Carbonate.

25316.—A firm in Genoa is in the market for sal ammoniac and carbonate of ammonia. Correspondence should be in French or Italian. References.

Dyestuffs and Chemicals.

25335.—A woman in France desires to secure an agency for the sale of American products, especially salt meats, oils and greases, hosiery, woolens, chemicals, dyestuffs and shoes. Correspondence may be in English. She is willing to deposit money in local bank for guaranty of payment. References.

Coal Tar, Anilines and Chemicals.

25504.—A man in Portugal is in the market for coal tar, drugs, anilines, chemicals, varnishes, etc. Quotations should be made f. o. b. New York. Payment will be made against delivery of documents or by confirmed letter of credit. Correspondence may be in English.

Potassium Chlorate.

25496.—A firm in England is in the market for powdered chlorate of potash for the Bombay and Calcutta market. Quotations should be made f. o. b. New York. Payment will be made by cash in New York. The potash should be put up in kegs or cases of one hundredweight with calico and paper lining.

Coal Tar from Gas Works.

25340.—A company in Italy wishes to purchase coal tar, or gas coal pitch in large quantities. This product is the refuse obtained from distilling coal tar in gas manufacturing and should be dried. For payment, credit will be opened in American bank. The tar or pitch should be shipped loose and preferably "in ballast." Correspondence may be in English. References.

DISTILLATES

News Notes of Chemical and Allied Industries

General Glass Products.

The J. O. Jensen Company, Geneva, N. Y., has been incorporated with a capital of $50,000 to manufacture glass products. The incorporators are J. O. and C. A. Jensen and J. Henle, Geneva.

Community Chemical Company.

The Community Chemical Company has been incorporated at Dover, Delaware, with a nominal capital of $5,000 to manufacture chemicals. The incorporators are L. B. Phillips and J. B. Bailley, Dover.

Paints and Oils.

Paints and oils will be manufactured by N. Z. Graves, Inc., at Philadelphia, Pa., following the recent incorporation of this firm with a nominal capital of $5,000. Nelson Z. Graves, Philadelphia, has been named as the principal incorporator.

Glass Specialties.

The King Glass Company, Kokomo, Ind., has been recently incorporated with a capital of $100,000 to manufacture glass specialties of various kinds. The incorporators are E. B. King, C. D. Wells and William M. Wells.

Paints and Chemicals.

With a capital of $220,000, the Markleed Chemicals Corporation has been incorporated at New York, N. Y., to manufacture chemicals and paints. The incorporators are L. H. Marks, New York; H. C. Aron, 55 West 10th street, New York, and H. M. Wise, Woodcliff, N. J.

New Chemical Manufacturers.

Chemicals will be manufactured by the Provident Manufacturing and Chemical Company, Los Angeles, Cal., which was recently incorporated with a capital of $10,000 by H. C. Hollins, Frank Hollins and D. W. Coons, Los Angeles.

Fore Chemical Works Incorporated.

Under the laws of New Jersey the Fore Chemical Works, Jersey City, have been incorporated with a capital of $497,000 to manufacture chemicals. The incorporators are M. W. Alexander, R. E. Breed and U. M. Fleischman.

Electrosynth Chemical Company.

With a nominal capital of $5,000 the Electrosynth Chemical Company has been incorporated to manufacture chemicals at New York, N. Y. The incorporators are J. M. Winston, H. and M. Abrams, 130 West 113th street, New York City.

New Plant for Potash Manufacture.

Mason Brothers, of Sausalito, Cal., have acquired 90 acres of land at Antioch, that state, and will erect a $500,000 plant for the manufacture of potash, acetone, ammonium sulphate, etc.

Heller & Merz Will Erect Two Buildings.

The Heller & Merz Company, Hamburg place, Newark, N. J., manufacturer of colors, dyes, etc., has awarded contracts for the erection of two new one-story brick factory buildings to cost $56,000.

Raritan Copper Works Adds to Plant.

The Raritan Copper Works, Perth Amboy, N. J., has completed the construction of a new two-story addition to its plant. The new structure is estimated to cost about $24,000.

Beckers Works Still Growing.

The Beckers Aniline & Chemical Works, Inc., East Eighty-third Street, Brooklyn, N. Y., is making rapid progress in the construction of new additions to its plant in the Flatlands section. The estimated cost is about $1,100,000.

Will Build New Retort House.

The Stackpole Carbon Company, 71 West Broadway, New York, has awarded a contract for the construction of a new one-story retort house at Mary's, Pa., to cost $30,000.

Chemicals of All Kinds.

The Staier Chemical Company, Newark, N. J., has been incorporated under the laws of that State with a capital of $50,000 to make and deal in chemicals of all kinds. H. Staier and J. C. Staier, both of New York, and F. W. Miller, of Newark, are the incorporators.

Brown-Ferres Co. Will Build.

The Brown-Ferres Company, Inc., Newark, N. J., manufacturers of phenacetine and other chemicals, have acquired a two-story reinforced concrete factory building on Meadow lane. The company is planning for the immediate erection of a new building about twice the size of the one just acquired.

Chemicals and Chemical Compounds.

The Compound Specialty Company has been incorporated with a capital of $50,000 at New York, N. Y., to manufacture chemicals and chemical compounds by S. Baer, 1286 Lexington avenue; M. L. Schaller, 176 West 87th street, and J. R. Roth, 180 St. Nicholas avenue, New York.

General Chemical Co. Builds Homes.

The General Chemical Company has commenced the construction of a block of thirty-nine dwellings for the workmen employed at its plant at Wilmington, Del.

Brown Considers Erection of Carbon Plant.

Alton Brown, of Pittsburgh, Pa., and those associated with him, have acquired 700 acres of land at Monroe, Louisiana, and are considering the construction of a $700,000 plant for the manufacture of carbon.

Salem Co. Adds to Plant.

The Salem Oil and Grease Company, Salem, Mass., is constructing an addition to its plant, and is planning to install new tanks and machines for the production of oils for leather tanners.

New Benzol Plant at Minneapolis.

The Minnesota Steel Company, Minneapolis, Minn., is engaged on the erection of a new benzol plant at that city in which it is expected that operations can be started before the close of the year.

New Bureau of Mines Study on the Coking of Illinois Coals

The Bureau of Mines, Department of the Interior, in co-operation with the Illinois State Geological Survey and the Department of Mining Engineering of the University of Illinois, has completed a study on the coking of Illinois coals, and has published the results of this investigation in Bulletin 138, by F. K. Ovitz.

Mr. Ovitz, in discussing the subject, says:

"In its endeavor to promote a more efficient use of coal the Bureau of Mines, in co-operation with the Illinois State Geological Survey and the University of Illinois, has undertaken an investigation of the coking of Illinois coals. The investigation was started by collecting from various sources the data regarding experiments already made by others; these data have been compiled and are presented herein.

"The present methods of using coal seem wasteful. When coal is burned in furnaces for the generation of steam, only the heat generated by the fuel is utilized; possible by-products are not only lost, but frequently are the source of the smoke nuisance. The volatile matter containing the tar and heavy hydrocarbon gases is difficult to burn completely in many furnaces, and its decomposition produces black smoke. When coal is coked in a by-product oven, the volatile matter is no longer a nuisance but, on the contrary, is the source of many by-products, including benzol, toluol, gas, tar, ammonia, and cyanogen, all of which increase the value that may be obtained from coal.

"The coke that remains after the volatile matter has been driven off is a valuable fuel that can be used for almost all purposes for which bituminous coal can be used, and it is necessary for some metallurgical work. It has about the same heating value as anthracite coal. Because of its cleanness and its burning without smoke, it is well suited for domestic heating and the generation of steam in plants where smokelessness is demanded. The use of coke for these purposes would do much to eliminate smoke in cities. The best grades are regarded as essential in many metallurgical processes for reducing ores to their metals.

"By-product coking in the United States during the past three years has increased greatly. When the ovens now in course of construction are completed, the total capacity of by-product ovens will be more than double what is was in 1913. This increase has led to a search for coals other than those now known to be available for use in by-product ovens. Tests with coals from the southern part of Illinois have indicated that coke from Illinois coal unmixed with other coals can be used for fuel purposes and that coke from mixtures of Illinois coal with low-volatile coking coal might be suitable for some metallurgical work. In the tests the yield of ammonia was larger than is obtained from Eastern coal.

"Evidently the development of methods by which good coke can be made from Illinois coals and the by-products recovered is a matter of high importance. Any investigation that will indicate how, by proper treatment, these coals can be made available to supply the market for coke and gas in the Middle West will increase efficiency in their use, and will aid in conserving the country's supply of high-grade coking coal.

"The first part of this report outlines the present factors in the problem of coking Illinois coals and points out the future prospects. The quality of coke from Illinois coals alone, and from mixtures of Illinois coals with low-volatile coals is described, and the uses for which the coke is suitable are discussed. The gas-making properties and the value of the coals for making by-products are noted. Desirable methods of preparation of the coals, the impurities in them, and the effect of the impurities on the value of the coals for coke and gas making are considered.

"The second part of the report deals with the character of Illinois coals, their nature, physical properties, and chemical composition. The nonhomogenous structures of the coal, the variation in composition of different beds, and even of the same bed in different localities are pointed out. Those districts in which the coals contain the smaller amounts of impurities and are more favorable for coking are grouped together.

"The last part describes the tests made and gives detailed results. The tests are considered under three classes—those with beehive ovens, those with by-product ovens, and those with gas retorts. The details are as complete as the material available permits. The results of a few tests of the coke for furnace or other use are given."

Copies of this bulletin may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

DECEMBER PRICES OF CHEMICALS

Acetone	35	36
Acid, acetic, 28%	5.25	5.50
Acetic, 56%	10.50	11.00
Acetic, glacial	48	.50
Boracic, crystals	.18	.23
Boracic, powdered	.18	.22
Carbolic, cans	.64	.67
Chromic, tech	1.20	1.25
Chromic, U. S. P	1.25	1.50
Citric, crystals	.76	.78
Cresylic, 95%	1.10	1.15
Hydrochloric, 18°	1.50	1.75
Hydrochloric, 22°	2.00	2.25
Hydrocyanic, dilute, 3%	.20	.22
Hydrofluoric, 30°	.05	.05½
Hydrofluoric, 52°	.10	.10½
Lactic, pure, 50%	.40	—
Lactic, tech., 50%	.15	—
Nitric, 36°	.06½	.06¾
Nitric, 38°	.06¾	.07
Nitric, 40°	7.36	7.50
Nitric, 42°	.08	—
Oxalic, crystals	.45	.46
Phosphoric, 85%	.35	.39
Phosphoric, 87½%	.36	.40
Picric	.75	.85
Pyrogallic, resublimed	3.15	3.25
Pyroligneous, tech., gal	.10½	.13½
Pyroligneous, tech, gal	.05	.05½
Pyroligneous, pure, lb	.05	.05½
Sulphuric, 60°	1.50	1.75
Sulphuric, 66°	1.75	2.00
Sulphurus	.03	.05
Tannic, U. S. P	1.30	1.35
Tartaric, crystals	.78½	.83
Alcohol, denatured, bbls	.85	.92
Alcohol, grain, 190, U. S. P	—	—
Alcohol, wood, 97%	1.15	1.17
Alum, ammonia, powdered	.05	.05½
Aluminum sulphate, technical	.02¾	.03
Ammonia aqua, 26°	.12	.16
Arsenic, white	.16	.18
Barium chloride	80.00	90.00
Barium sulphate, powder	—	—
Barium nitrate	.12	.13½
Borax, crystals, bags	.07¾	.08
Calcium peroxide	1.50	—
Calcium sulphate	.10	.20
Carbon bisulphide	.07½	.08½
Cobalt, metal, oz	.32	—
Cobalt, sulphate	—	.50
Copper carbonate	.45	—
Copper nitrate	.45	.50
Formaldehyde, bbls	.16½	.16¾
Glauber's salt, 100 lbs	.75	.85
Glycerine, C. P., drums	.69	.70
Iodine, resublimed	3.50	3.55
Iron oxide	.13	.15
Iron sulphide	—	—
Potassium bichromate	.45	.46
Potassium chlorate, crystals	.55	.56
Potassium cyanide, mixture	.55	.60
Potassium permanganate	4.00	4.25
Rochelle salts	.39	.39½
Sal ammoniac, white gran	.15	.16
Soda ash, dense	4.00	4.25
Sodium acetate	.10	.13
Sodium benzoate	1.55	1.60
Sodium bicarbonate	.02¾	.03
Sodium chlorate	.24½	.25
Sodium cyanide	.55	.60
Sodium nitrite	.35	.40
Sodium phosphate	.05	.06
Sodium salicylate	1.25	1.30
Sodium silicate	1.75	2.00
Sodium sulphide	.02	.02½
Sugar of Lead, powder	.17	.18
Sulphur, commercial	3.25	3.50
Sulphur, flour	3.85	4.00
Sulphur, flowers	3.95	4.10
Tin bichloride	.19¼	.19½
Tin, crystals	.39	.39½
Tin oxide	.64½	.66½
Zinc carbonate	.25	.27
Zinc chloride	.10¼	.11½
Zinc oxide	.16	.21
Zinc sulphate	.05½	.06

Essential Oils.

Almond, bitter	5.25	16.00
Amber, rectified	1.75	—
Anise	1.05	1.10
Cassia, rectified	1.90	2.00
Cedar, leaf	.95	1.00
Citronella, drums	.56	.57
Cloves, bottles	3.35	3.40
Eucalyptus, American	.65	.67½
Geranium, Algerian	5.25	5.30
Lemon	1.10	1.20
Limes, expressed	6.10	6.25
Mustard, artificial	22.00	26.00
Orange, Sicilian	3.00	—
Pennyroyal, American	1.65	1.85
Peppermint, cases	4.00	—
Rose, natural	22.00	—
Rose, synthetic	2.75	3.00
Safrol, drums	.40	.45
Sandalwood, E. Indian	11.25	11.50
Sassafras, natural	.95	1.05
Thyme, white	1.35	1.50
Wintergreen, leaf	4.15	—

THE CHEMICAL ENGINEER

VOL. XXVI. JANUARY, 1918 No. 3

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

DYE CONVENTION NUMBER

CONTENTS, JANUARY, 1918

American Color Manufacturers Agree to "See It Through" 82
- —Officers and Committees 84
- —The Convention in Detail 84
- —Frank Hemingway's Address 86
- —H. Gardner McKerrow's Address 89
- —Benjamin H. Kaye's Address 93
- —Organization Discussed 94
- —Dealers Withdraw 96
- —David W. Jayne's Address 96
- —Dr. E. W. Pierce's Address 97
- —E. S. Chapin's Address 99
- —Vote to Organize 100
- —Dr. J. Merritt Matthews' Address 100
- —Albert E. Parker's Address 101
- —Bradford Webster's Address 102
- —Dr. Grinnell Jones' Address 102
- —Tariff Discussion 104
- —Firms and Representatives 105

Inorganic Chemical Synonyms 107
Elton R. Darling

Ultra Violet Light: Its Application in Chemical Arts. Part X 113
Carleton Ellis and A. A. Wells

Chemical Investigation, Efficiency and Control 118
Conducted by Charles B. Davis

Editorial Comment 119
- —1918
- —The German Dye Trade After the War
Thomas H. Norton

Madero Bros. Repudiate Employee's Action

Vigorous action on the part of officials of Madero Brothers, Inc., the well known importers and exporters of chemicals, New York, will, it is likely, be taken to clear away the blot upon the firm's reputation which, for a few hours, threatened them as a result of the arrest of Tonko L. Millic, of the firm's chemical department, and said to be an Austrian citizen, in connection with the alleged substitution of thirty-two cases of salicylic acid in place of quinine which had been ordered for use in an Italian military hospital.

At the time this issue went to press, Millic was being held at New York police headquarters on the specific charge of grand larceny, it being alleged that he misappropriated $25,000 in connection with the transaction. The cases in question, which were labeled "Quinine," were seized by officers of the Army and Navy Intelligence Service at Pier 7, Brooklyn, N. Y. Millic's arrest followed.

Head of Firm Hurries Back.

Ernesto Madero, the firm's president, who was in the South, was immediately reached on the long-distance telephone and started back for the New York office at once. Pending his arrival, other officials of the company declined to discuss the affair in detail.

When interviewed by a representative of the Chemical Engineer, Jose Miguel Bejarano, of Madero Brothers' chemical department, declared that a full statement would be forthcoming upon Mr. Madero's return.

Affair Does Not Affect Firm.

"Mr. Madero is expected to arrive within two days at the latest," said Mr. Bejarano. "The present officials of the company do not feel themselves authorized to make a statement until the arrival of the head of the firm."

"The only assertion they can make," he continued, "is that the present unfortunate affair is one concerning exclusively an employee of Madero Brothers, and not affecting the firm in the least."

It is alleged that Millic received the check in payment for the shipment of "quinine" and deposited it to his own banking account. Although no direct statement was made, it is rumored that drastic action of some description toward clearing away the temporarily implied stigma will follow.

Western Manufacturing Company.

The Western Manufacturing Company has been organized at Newark, N. J., to manufacture wood chemicals. It will operate a plant at 615 South 19th street for that purpose.

AMERICAN COLOR MANUFACTURERS AGREE TO "SEE IT THROUGH"

By Laurance T. Clark

Characterized by a Lack of Friction and a Unanimity of Purpose Which Surprised Not a Few of Those Who Attended, the Convention of Dye Manufacturers and Dealers Held in New York Successfully Demonstrated Itself to Be Based Upon an Idea Which Is Fundamentally Sound, and Brought About the Organization of the Industry in America. A Detailed Account of the Transactions, Accompanied by the Various Addresses in Full, Is Contained in the Present Article.

Agreeing definitely to meet again on Wednesday, March 6, for the purpose of completing a permanent organization, the long-heralded gathering of some 200 dye manufacturers and dealers held in New York, adjourned after a conference which lasted two days and which was characterized by a striking lack of personal jealousy as well as a very marked spirit of mutual confidence and willingness to throw aside immediate individual interests for the common good.

When the color men again convene a certificate of incorporation will have been prepared and filed for the prospective association, and they will be presented with a tentative constitution and by-laws for consideration and adoption. They will also hear a report from a special committee which will be appointed to confer with the United States Tariff Commission on the subject of duties on intermediates and dyestuffs after the war, and will be invited to select a name for the new trade body.

"Dyestuffs Association of America."

This preliminary work will be performed between now and March 6 by the Organization Committee, of which Dr. J. Merritt Matthews, consulting chemist for the Grasselli Chemical Co., New York, is chairman. Some of the names suggested to the committee for selection were "Dyestuffs Association of America," "American Dye Manufacturers' Association," "National Association of Dyestuffs Manufacturers" and "American Dyestuffs Association." This last was objected to because the initials are the same as those of the American Druggists' Association. The first of these was finally selected.

If the recent convention is any criterion, this youngest of industrial organizations already reveals vast potentialities for efficiently concerted action which augers well for the future of the industry in this country. It was not that differences of opinion were totally wanting, but that they were so logically and rapidly straightened out to the satisfaction of all parties concerned, which gives eloquent testimony to the presence of a universal desire to subordinate personal preference to the best interests of the trade at large. A striking indication of this was the almost unique fact that after very thorough discussions each vote taken was, without exception, unanimous.

Manufacturers vs. Dealers.

The convention was opened by H. Gardner McKerrow, of E. F. Drew & Co., Inc., to whom credit is principally due for an amazing amount of energy spent in getting the representatives of the industry together under one roof for the first time in its history. Very early in the meeting the inevitable question arose as to the relative status of manufacturers and dealers. This immediately led to one of the day's most important discussions, which is taken up in detail further on, and which finally culminated in the two bodies meeting separately for a short while at the suggestion of B. P. Donnelly, of the Holland Aniline Co., Holland, Mich.

As the result of an interchange of views between two committees representing these interests, it was finally voted that membership in the organization is to consist of two classes; the first, or active members, comprising manufacturers of intermediates and dyestuffs, and the second, or associate members, consisting of the dealers. It is probable that there will be added to these a third class composed of representatives of allied interests and including makers of chemicals, makers of machinery, trade publications and the color using industries generally.

Dealers Will Have No Vote.

According to a decision reached at the convention, dealers will have no vote in the organization, but will have one of their number as a member of whatever executive body may be appointed to administer its affairs. It is expected that the third class will pay only nominal dues and will have the privilege of attending the public meetings of the organization, the use of its secretarial advantages, including all propaganda and statistical information, and in the case of the color users, the official information of the activities of the members, new colors produced, names of makers of special colors and general exchange service.

Rumford Hall, in the Chemists' Club building at East Forty-first street, New York, will again be scene of activities when the dye men come togeth

ANOTHER "DECLARATION OF INDEPENDENCE."

This is how the dye manufacturers of this country looked as they gathered to organize in Rumford Hall, New York, on January 22, 1918. No one who was present is likely to forget the taking of this picture. For the benefit of those who were not, we can only ask: How would you like to be told to "look pleasant" four consecutive times—and each time have the flashlight fail to work? No wonder Mr. McKerrow moved! Ten years from now this picture will be of historic interest, for it was the only one made of the gathering.

for what will be known as the first annual meeting of the association. The time set is 10:30 o'clock, and it is probable that the hospitality of the club, including the restaurant facilities, will again be extended to all delegates for the day. Judging from the numbers which availed themselves of this privilege, the action of the club directors was appreciated.

Officers and Committees.

Frank Hemingway, head of the well known firm which bears his name, was asked to preside over the convention, and after laughingly questioning the good judgment of those who approved him for the post, and expressing his failure to see "why Mr. McKerrow refused to hold his own baby at the christening," brought to the chair a personality which speedily revealed his ideal qualifications for this somewhat trying post.

Mr. Hemingway was unable to be present on the second day of the meeting, and David W. Jayne, of the Barrett Company, New York, who consented to act in his stead, also handled the meeting in an efficient manner. C. Cyril Bennett, publisher of a trade magazine, acted as secretary. Charles Jenkinson, of the National City Bank of New York, was chosen treasurer and went about the abhorred duties attendant upon this office in a manner which, it was voted, rendered them as nearly painless as it is possible for such things to be.

The organization committee consists of Dr. Matthews, chairman; Mr. McKerrow, L. A. Ault, of Ault & Wiborg, Cincinnati, Ohio; August Merz, of Heller & Merz, Newark, N. J.; W. S. Woodward, eastern manager for the Sherwin-Williams Co., New York; T. N. Hyndeman, of the Hydro-Carbon Co., Philadelphia, and S. R. David, of the National Aniline & Chemical Co., New York.

The committee which represented the manufacturers at the time of the separate meetings consisted of Dr. Matthews, Mr. Ault and Mr. Merz, while the dealers' committee comprised Bradford Webster, of the Dye Exchange Corporation, New York, J. M. Hollywood and J. F. Beatty.

The Speakers.

The speakers and their addresses, practically all of which are reproduced in full further on in the present report, were as follows: Mr. McKerrow, Mr. Hemingway, who spoke on the possibilities of rightly conducted trade organizations; Benjamin M. Kaye, an attorney who specializes on trade association formation, who outlined the proper legal procedure for organizing an industry; Mr. Jayne, who told of the recently organized Chemical Alliance; Dr. Edward Wallace Pierce, chief chemist of the U. S. Conditioning and Testing Company, New York, whose topic was "Standardization;" E. S. Chapin, of Boston, who pointed out the possibilities of conservation as a direct result of the prospective organization; Albert E. Parker, who had for his subject "The Patent Law and Its Relation to Dyestuffs;" Bradford Webster, an expert on trade arbitration, and Dr. Grinnell Jones, of the U. S. Tariff Commission. Dr. Allen Rogers, of Pratt Institute, Brooklyn, was also expected to address the convention, but was unable to attend.

THE CONVENTION IN DETAIL.

There was an attendance of about 125 manufacturers and dealers when Mr. McKerrow's gavel fell shortly after 10:30 o'clock on Tuesday morning, January 22. And if, unlike the shot fired at Fort Sumter in 1861, it was not heard quite " 'round the world," it is at least certain that it was heard as far away as Berlin.

Preliminary Steps.

He then proceeded to outline the various causes which had impelled him to take the initiative in bringing the various factors in the dye industry together.

"The fact of your presence here today," he said, "indicates your interest in the ideas which have called us together, and your attention is due to whatever it may appear wise to do in order to further the dyestuff industry and place it in its proper position as one of the important industries of our country. When I was asked by a number of gentlemen connected with the dyestuff industry and by several papers to take steps for the calling together of all who were legitimately interested in the manufacture and sale of dyestuffs, I objected on the grounds that there are others who have been much longer associated with the industry than I.

"I had, however, made some public recommendations regarding the advisability of standardizing Americon colors in an address delivered at Springfield in May, 1917, and December, 1912, and was assured that an effort to get together would be well received. The first letter received a response so extrordinary as to leave no doubt in my mind but that there was a widespread desire to establish and entrench the industry.

No Single Interest Responsible.

"From the first I have endeavored to impress upon all of those interested that this is a movement not instigated by any single interest, but a calling together of the trade as a whole in the hope that a crystalizing of the interests of all can be effected through sympathetic and concerted action for the benefit of all. I have had the co-operation of several gentlemen well known in the industry at several meetings during the past month, and have had an expression of their opinions as to the various points we discussed. After discussing these matters with Mr. Benjamin M. Kaye, who has been of great assistance, I decided that it was desirable, as was the original intention, that this should be simply a meeting to decide whether or not we shall have a trade organization, and, if so, to mark out the general lines on which it should be conducted.

"If we approach the question in the spirit of fairness and co-operation, with a single eye to consolidating and preserving what we have already won, free from any tendency to think that maybe our competitors individually are still working towards the same end, that of making our country free from foreign control

POST-CONVENTION COMMENT

H. Gardner McKerrow.

"The results of the convention should be a source of deep gratification to all concerned. There is no doubt but that an association of this kind was badly needed by the trade. The organization is now a reality, and the fact that every vote taken was unanimous is eloquent testimony to the unity of sentiment which animates it."

Charles Jenkinson.

"Speaking as an observer rather than an actual participator, there is every reason to feel optimistic over the future outlook for the new association. It can be best judged by the character of the concerns going into it, and already more than eighty first-class firms have taken an interest financially in the organization. I am certain there will be many more by March 6."

Dr. E. Wallace Pierce.

"The general program went through precisely as expected. It could not have been predicted in advance that such a sharp line would be drawn between manufacturers and dealers, but it is to be hoped that a closer union between the two will result. The association is going to eliminate from the dye business the irregularities which almost cost it the confidence of the consumer, and it is believed that it will bring about more amicable relations between producer and consumer, which cannot fail to result in better business."

(c) Underwood & Underwood, N. Y.

The Kaiser.

"A splendid example of American schrecklichkeit. Donnerwetter! Words cannot express my disgust at such proceedings. Have the Americans, then, sunk to such depths of depravity that they would thus defeat the aims of Kultur? I regard the whole affair as disgraceful, un-German, and therefore unthinkable, and may its perpetrators be properly punished for their wickedness. Gott strafe McKerrow!"

Scattered

"How is the disorganized effort of 130 American concerns going to meet the organized effort of 13 huge, active German concerns?"

—Benjamin H. Kaye

of one of our vital industries, and with all unworthy jealousies forgotten and laid aside, I am persuaded that we shall accomplish something."

"I take it that the first step to be taken is to effect a permanent organization and to this end we may proceed to the election of a chairman to conduct our meetings today and tomorrow. The election of this chairman, gentlemen, is up to you, but if it will be of any assistance to you in proceeding at this point, I would like to suggest that Mr. Frank Hemingway would make an ideal chairman, as he is a man who is well known and widely esteemed throughout many industries."

MR. HEMINGWAY'S ADDRESS.

Mr. Hemingway's nomination was promptly seconded and his unanimous election followed. Upon taking the chair he remarked that he hoped Mr. McKerrow had given more thought to the work ahead than he had to the qualifications of the proposed temporary chairman. "This matter is Mr. McKerrow's baby," he continued, "and just exactly why he refused to hold his own baby at its christening is something I do not understand, and I am free to confess that I think that both he and the gentlemen who helped him at the informal meetings held last week have made a very serious mistake in insisting upon my acting as temporary chairman at this meeting, as in the first place I have very few ideas of my own, and a most complete inability to express even these few."

"The gentlemen who insisted upon my acting as temporary chairman today have been frank enough to say that they want me because I do not count for anything in the industry, anyhow, and yet know a little something about it. It was thought dangerous to have, as the presiding officer here to-day, an important man representing any particular manufacturing interest, for fear the meeting as a whole should gather the impression that any large interest or interests proposed to run either this convention, or determine the policy of the National Dyestuffs Association, if and when formed, and, to an extent, I think they were right.

"If to-day you elect to form an Association which you may or may not choose to call the National Dyestuffs Association of America,—and, by the way, the latter is preferable, for the initials of the former are identical with those of the National Druggists' Association,—above all things, you must bring about an organization which is for the benefit of the industry as a whole and for all reputable manufacturers and merchants engaged in it, without regard to their size or importance, but with a very strict regard, on the other hand, to their repute and the seriousness and earnestness of their efforts.

"It is too bad that at the outset I am forced to say something which may not be very pleasant to Mr. McKerrow. It is too bad because I feel that the entire industry is very deeply indebted, indeed, to Mr. McKerrow for what he has already done in waking us all up to the crying need for the development of some organized co-operative effort. Mr. McKerrow has been so impressed with the necessity of standardization of products that he has called particular attention to this feature and, I think, created the impression among many of you that the main function of the

Focussed!

"Standardization is the big, burning question before this meeting."

—Dr. E. W. Pierce

association, if formed, will be the standardization of dyestuffs.

Standardization Not Most Important Point.

"He may set me right on this point later, but I think that Mr. McKerrow realizes that standardization is but one of the functions of an association, and by no means the most important. And now, gentlemen, I am going to say something to you all that will probably be horribly criticized, or lead you to believe that I have been associating with the Bolsheviki, and that is that, valuable as the formal procedure and official acts of a business association may be, they count for little as compared with the fact that the members of the association meet together and have a chance to discuss their common problems.

"It is a safe bet that most of you gentlemen here are members of two or three business associations and that you must realize how much time is wasted in meetings listening to the long and elaborate reports of committees and bureaus,—the Credit Bureau; the Fire Insurance Bureau; the Arbitration Committee; and so on and so forth.

Elimination of "Red Tape."

"The larger business associations realize this and print and distribute the deliberations of their committees so that correct action may be taken very quickly at the meetings, at which the problems are discussed, leaving more time to the members to meet together without any set order of business. In this way they have an opportunity, by friendly association and contact, to learn something of their own difficulties and to plan to solve them.

"We cannot solve our scientific and our technical problems by formal talks, nor can we devise general orders of business that will help to solve them. Our chemists work on their several problems, and, from time to time, come together to learn what progress has been made, and, in the end, the chemists and the engineers and the executive heads, familiar with all the problems and their solutions, together use their best intelligence to elaborate a successful working unit.

"At the meeting of the American Institute of Chemical Engineers last December I made so bold as to refer to the Gary dinners. We must admit that Judge Gary is an organizing genius and that he has faced the greatest industrial problems of this day when industry together with true progress blends with politics about as well as oil and water.

Organization Must Be Flexible.

"How often have we individually become enraged at some unpleasant little turn in a letter, only to find everything smooth out when, for the first time, we have met the writer thereof! I recommend to you gentlemen that if you form an association you form one that shall be flexible, and, above all, one that shall bring its members together frequently without too much routine or detail work for them to do. Let small active committees work out the solution of individual problems, but let the members meet often and acquaintanceship ripen into friendship.

"You manufacturers here to-day are tilling what is practically virgin soil in this country. To bring about competition and later to eliminate it by agreement in such a virgin field is to do something that is in the first place absurd and in the second place illegal. The powers that be, in Washington, have stretched the Constitution this way and that until it is now more or less out of shape, but I do not think the day will ever come when it will be illegal for men in this industry, or any other, to be friendly and to be familiar with their common problems.

"The Agricultural Department has placarded the South with the slogan 'Diversify Your Crops.' Is it not obvious that unless the farmers of the South come together, or are helped by some central body, such as the Department of Agriculture, they cannot very well determine just what to grow? They may all stop growing cotton and turn to corn. Then there would be a shortage of cotton and woeful competition in corn. You manufacturers want to 'diversify your crops,' but you have little or no opportunity of finding out what the other fellow is either making or preparing to make on a large scale. There is no need to elaborate on what happened with Aniline Oil and Phenol and a dozen other products, for you are all familiar with their history in the past three years.

Objects of Association.

"The next most important point for your consideration, I think, is the matter of the stated objects and the management of the Association. It is obvious that many manufacturers will hesitate to take an active part in the work of an association before they know the definite objects to which the association is committed, and, moreover, just exactly what qualifications are necessary for membership. The stated objects are not so serious, for when all is said and done associations of this kind are formed for the welfare of the industry as a whole, and, taking it by and large, that simple statement covers the situation.

Membership Qualifications.

"The matter of membership qualifications is, however, very serious, for I feel that no association should open its doors so wide as to admit to membership men who may plan to use the association for their own ends rather than to use their own knowledge and energy for the welfare of the association, which means the industry. Therefore, I think the most important of all the preliminary steps is the choice of the Committee that will bring about the formal organization of the association, and, at the same time, determine qualifications for membership, and, further, I feel that such a Committee should be a large and representative one.

Failure of Perkin's First Plant.

"I cannot express to you gentlemen the intense and personal interest I take in this development. Among my earliest recollections are some of the evidences of the failure of the British Dyestuff industry. Sir William Henry Perkin's first patent, which was entitled "Dyeing Fabrics" was dated August 26, 1856. Perkin's plant was erected at Greenwood Green, in London, and not long afterwards a plant was erected at Marsh Gate Lane, Stratford, London, E., by Evans, Kant & Co.

"These people at that time had the most up-to-date method for the manufacture of Rosaniline. They went along successfully for some time and then failed, and my father bought the property and used it for his own particular manufactures. In the Evans Kant Rosaniline process the oxidation was brought about by Arsenic Acid. The Aniline and Arsenic Acid were introduced together into a U shaped boiler and the mass was agitated mechanically while it was heated. One of these boilers produced in eight hours about a ton of magenta melt. In the last stages of the process lime was used to take up the arsenic and they obtained as a by-product very large quantities of arsenite of lime, very strongly colored with magenta.

Utilization of Apparent Waste.

"When I first saw that plant at the tender age of seven or thereabouts there was literally a hill of this material which spread a strong red liquor over the factory whenever it rained, and as you all know, it rains in England most of the time: and the first lesson I had of the utilization of waste products was what my father did with that hill, which stood just about where he wanted to place some furnaces. He took some of the material, washed it, levigated it, dried it and powdered it and sent samples to Prof. Riley in Washington and to Prof. Bessey in Ames, Ia., as a possible insecticide for use against the cotton worm which was then eating up most of the cotton crop in the South.

"The reports from Washington and Ames were so encouraging that my father made his first trip to this country in 1878. Prof. Bessey suggested to him as Paris Green was Green, this material, being purple and produced in London, should be called London Purple, and so it was named. I referred to the old books recently and found that long before the hill was demolished it had produced in profits an amount considerably in excess of what was paid for the entire property.

More Recent Achievements.

"I do not want you to think that to-day my sole interest in the industry is a fond hope that some mountains of valuable by-products will be forthcoming, for my benefit: for, as a matter of fact, my thoughts lie in one direction only, which is that American, French and English genius, intelligence, industry and energy should be enabled, by proper organization and adequate governmental co-operation to reach the success they deserve. No one can deny that the work already done and the results already obtained in this country are simply marvellous. There are made here today many of the most difficult pharmaceutical products, that three years ago we were told could never be made in this country. But the work is "spotty." The heads of the British dyestuff companies feel that under the most favorable circumstances possible it will be ten years at least before the perfection of organization developed by the German companies can be approached. Therefore, I repeat that to attempt at this early stage too much in the nature of detailed organization for an association, is to invite disaster, and to create greater confusion than already exists. It will be like attempting to instal an elaborate cost accounting system (and I speak feelingly and from experience) in a brand new industry, that has yet to produce its first commercial batch.

Relations with Government.

"Finally, there is the all important matter before you of a fair and helpful governmental attitude and, in this connection, let me read you six lines from an editorial on 'Science and Industry' which appeared in the 'Manchester Guardian' on June 30, 1917:

> " 'From ill-informed public opinion one cannot expect right minded public action. Any community that holds itself apart from the general body and is content to deplore the existing state of things without a vigorous effort to alter it is bound to suffer when public action comes to be taken.'

"Those lines to my mind are all-sufficient to justify you gentlemen in forming an active association. If you go ahead I pray you may succeed, and in any event I feel that we are all of us greatly indebted to Mr. McKerrow for the work he has done and for the great constructive effort he has made."

MR. McKERROW'S ADDRESS.

Mr. McKerrow then explained in detail all that might be accomplished through the formation of an association as follows:

"Mr. Chairman, Gentlemen of the Convention: When the suggestion was first made that the dyestuff manufacturers and dealers of this country should be invited to take part in this convention, the central idea which prompted the move was that of the advisability of devising some means for the standardization of American dyes.

"As the preparations for this meeting progressed, however, the initial idea expanded considerably until it became apparent that the first and most advisable step to be taken was to form a commercial association representing the dyestuff industry as a whole, and having under its care and jurisdiction not only the question of standardization, but other collateral questions of equally great importance to the industry, such as questions of tariff, patent law as affecting the dyestuff industry, arbitration of disputes, protection of contracts and other matters which, as the new industry becomes of more and more importance, call for treatment of an authoritative nature in the interests of all rather than the individualistic attention from diverse and divided interests which is all that such questions have received hitherto.

"To Be, or Not to Be."

"This, therefore, gentlemen, will be the first matter to be brought to your attention, the question as to whether we shall form a National Dyestuffs Association, and if so, the form it shall take, the duties it shall assume and the character of its government. It would appear that the right time to effect such a central organization is during the infancy of the industry, for it is then that the interests of all factors, both large and small, can be most equitably safeguarded and that the fundamental basis of its ultimate control can be established under such conditions as will best adjust themselves automatically to whatever its future growth may be.

Mr. Frank Hemingway.
Who Acted as Chairman of the Dye Convention

"As regards standardization, no definite conception as to how this could best be done was available at that time, but as the responses to the original invitation were almost without exception of an approving, and even an enthusiastic nature, and as they came from a very large proportion of those actively engaged in the industry, the idea began to take shape, and a great deal of expression of opinion took place; many experts in the dyestuff business were consulted; and others who had been identified with questions of standardization in other lines of industry were asked for their ideas.

Conflicting Views on Standardization.

"While the general idea of standardization was almost universally admitted to be something which it was eminently desirable to accomplish, a considerable conflict of opinion developed. By some it was characterized as an "iridescent dream," an ideal which is too far beyond our reach to attain; by others as a proposal which led to such complications and difficulties as to make it impossible of practical fulfilment; and still others did not hesitate to say that it was perfectly feasible and could be developed and carried out on perfectly proper and scientific lines if it was approached with an open mind and in a proper spirit.

Germany Did It.

"The opposition to it may be roughly classified as of three kinds,—first that of the man who honestly believes that it cannot be done, and in this regard I would remind you gentlemen, that it certainly was done by the German dyestuff manufacturers, and if it could be done by them, there is no conceivable reason why it cannot be done by American manufacturers. We have at the present time a complete list of probably less than one hundred aniline colors made in this country and these are for the most part of well recognized standard types, whereas it must be remembered that the standardization of German dyes included a line of upwards of one thousand colors, including not only distinct homogenous colors in themselves but a vast variety of compounds and mixtures and shades. It would not seem to be impossible, therefore, that at this stage of the development of the industry some effective means of laying the foundations for a system of standardization could be accomplished which would adjust itself to the future growth of the industry.

An Average, Workable Standard.

"It is not suggested that in establishing such a line of standards under the authorization of the National Association that the very highest types and strengths of colors produced should be adopted, to which all manufacturers would be expected to conform, but that an average, workable standard, which would be within the reach of all manufacturers honestly endeavoring to produce reliable goods, should be devised. It is quite possible that some offerings may run ten or even twenty per cent. higher than this standard, in which case the material offered would be worth relatively more money, while other offerings might be ten or twenty per cent. below the standard, in which case the manufacturer would be entitled to the value represented by his material or would be impelled to improve his method of production so as to reach the trade standard.

Standardization Will Aid Government.

"It is to be borne in mind further that it is practically indispensible to the purposes of the United States Government that some form of standardization should be adopted for the purposes of assessing and levying duties on imported colors.

"Wherever this duty takes the form of a specific rate, that is to say an impost of so much per pound, the question of the degree of concentration is immediately raised. There must be a starting point which the Government can adopt and against which importations can be compared for the purpose of determining the degree of concentration. It has been shown by past experience that dyestuffs can be imported of four and five times the concentration of ordinary recognized trade standards, and yet these importations carry no higher specific rate per pound than the trade standards as recognized before the war, thus defeating a very large proportion of the protective intent of the act. It is certain that if the dyestuff industry does not devise some means of standardization which the Government can adopt, an attempt to do this will be made by the Bureau of Standards in Washington. Would it not be far better, therefore, for the industry to devise a method of standardization which will be satisfactory to the Government, which will protect the interests of the dyestuff manufacturers and dealers, and which will, at the same time, also protect the interests of the consumers of dyestuffs, rather than leave it entirely to the functions of the Bureau of Standards, which would necessarily act in a more or less arbitrary way and simply with a view to facilitating the assessment of duties on imported dyes?

Negligible Opposition.

"Another species of opposition to the question of standardization has been from the purely technical interests in contradistinction to the practical interests. These gentlemen seem to be opposed to the idea chiefly on the ground that it has never been done hitherto and therefore that it is not amenable to accomplishment. This is the kind of opposition which inevitably confronts all new movements of this kind, and which can be safely left to take its proper place in the final consideration of the question.

More Sinister Motives.

"A much more dangerous and insidious opposition is that of those elements which seem to think that it is not to their interest to see any method of standardization adopted for American dyestuffs. Whether this is actuated by a belief that they themselves will establish and provide a standard to which all other makers will be compelled to align themselves or go out of business, or whether they have even more ulterior motives, and have an unexpressed idea of keeping the American dyestuff industry in a chaotic and confused condition and thus render it a fertile field for re-exploitation in the interests of the German dyestuff manufacturers when normal conditions are restored, is a question that should be carefully considered and guarded against.

"Whether it is feasible or not to establish a method of standardization on the outline suggested is entirely in the hands of you gentlemen to determine.

Registration of Samples.

"There is one thing, however, that can be accomplished. Such a Bureau of Standardization as might become one of the influential factors in the new dyestuff organization could effectively operate at least as a bureau of which I will call, for the want of a better term, registration. To it could be submitted types of the colors made by the American dyestuff makers as representing the standards which they propose to follow. These could be definitely tabulated and filed, and any consumer purchasing dyestuffs represented to be offered under the scale of standards adopted by the National Association would have the right to submit a sample of the delivery made for authoritative comparison with the original type standard as offered by the maker in the registry of the bureau. If the delivery should prove to be inferior to the type sample, it would be within the province of the Bureau of Standardization to call the attention of the manufacturer to that fact so that he might have an opportunity to correct his process and to make such allowance as would be proper to the consumer who had received the delivery, something which all reputable manufacturers would gladly seize an opportunity of doing. If, however, there should be a maker of dyestuffs who persistently made inferior deliveries and who refused to be bound by the original type deposited with the Bureau of Standardization, it would then be within the province of the National Association to expel such a maker from membership, and to cause him to lose his standard before the dyestuff consuming public.

Would Help Export Trade.

"This would in itself tend to eliminate the dishonest manufacturer and dealer, and it would overcome the evil from which the industry has suffered as regards inferior export deliveries which during the past year has done more to injure the reputation of American dyestuffs in foreign countries than any other one thing.

"It is suggested that a copyrighted name and insignia should be adopted which all members of the association in good standing shall be entitled to use on their letterheads, billheads, on their advertisements, or elsewhere, which shall be a badge of quality and which will so come to be regarded by the consumer.

"This is all that I need to say in the way of suggestion on the question of standardization, and I can safely leave it to you gentlemen to offer such suggestions as may occur to you, based on your own experience, with a view to devising some proper means for evolving a method of procedure which is universally recognized to be a desirable, and even an indispensable thing, with a view to the permanent establishment of our industry as an asset in American industrial life.

Arbitration.

"On the question of arbitration, this again is something which is essentially collateral to the question of standardization. Our courts have been congested with disputed cases during the past three years, practically all of them based on claims that deliveries have not equalled samples offered. In some cases these claims have been made in good faith; in others they have been just as evidently made in bad faith and in order to offset the conditions caused by a falling market or to obtain discounts to which the purchasers were not entitled. At present, the only way of adjusting these is through processes of law, and to this there is no limit of time or expense involved.

"If the two parties to a dispute see fit to voluntarily refer the question at issue to an authoritative central organization and to submit the respective merits of the dispute to this body with the knowledge that the claims will be quickly and authoritatively settled, a vast amount of time and expense will be saved, not only to the dyestuff dealer but to the consumer.

"Of course, this all predicates the establishment of a Bureau of Standardization under the aegis of the National Association which will be composed of business men and chemists who would be absolutely impartial and whose operations would be above suspicion and entirely confidential. It is not to be believed that such a body could not be organized from the ranks of the dyestuff industry; the outlook for the industry would be dark indeed if it should prove to be impossible.

Protection of Contracts.

"Another issue closely allied to the questions of standardization and arbitration of disputes is the one of the protection of contracts. The same body could very properly be invested with an adjudicating power as regards the protection of contracts. This is a question which is going to be of vital and widespread interest when conditions begin to attain normality, even if it has not become an active factor in the business as yet.

"In the panic-stricken times of 1915 and 1916, the color consuming industries were willing to sign contracts at almost any price, some of these contracts running for periods of two and three years from that date. Now a contract is not a contract unless it is equally binding on all parties thereto, and the difficulty is that a great many contracting parties only desire to be bound by a contract while it still operates in their favor. As soon as the market falls and prices range lower, they are apt to demand to be released altogether from the contract, or to have it adjusted so as to correspond with the new conditions. Where the manufacturer can do this without loss to himself by reason of his ability to buy his raw materials at lower cost, it is undoubtedly commercial wisdom for him to do so; where, however, the manufacturer has committed himself in good faith to other contracts on his part for raw materials, to which he is compelled to adhere, a breach of contract on the part of his customer at once works manifest injustice to him.

"If, therefore, there is a central authoritative board in which both the dyestuff manufacturers and the consumers have confidence, to which the merits of such a dispute as regards contracts could be submitted, shorn of endless litigation and limitless expense, it would be of unquestionable value to all parties, and its decisions, besides being rendered with reasonable promptness, would necessarily be based on commercial considerations of equity, rather than on the abstruse and mystifying construction of law.

The Tariff.

"One of the most important points for consideration by this convention is the question of an adequate degree of protection to be afforded to the industry by the United States Government. We have with us today representatives of the United States Tariff Commission, and Dr. Grinnell Jones will address us later, and give us some idea of the work that this Commission has already done, and proposes to do, to effect a tariff which shall insure the industry against extinction when the present disturbed conditions are past.

"Whether the present rates of 30 per cent. ad valorem and 5 cents per pound specific on finished dyestuffs and 15 cents ad valorem and 2½ cents per pound specific on intermediates is sufficient to enable the industry to meet post bellum competition is a question on which the United States Tariff Commission would like the expression of opinion of those engaged in the industry.

Unwise Features of Tariff Law.

"There are other features of the present tariff law as applying to dyestuffs which are unquestionably unwise, and are a menace to its permanent existence. I refer to the provision that after five years from the passage of the act in 1916, if the President should find that 60 per cent. of all the dyestuff requirements of the country were not made in the United States, he could arbitrarily by proclamation annul and cancel the specific rate of duty, and furthermore, that in any event after five years from the passage of the act, one-fifth of the specific rate shall be automatically dropped until at the end of another five-year period, the entire specific rate shall have been eliminated.

"How the estimation of whether 60 per cent. of the dyestuff requirements of the country shall be calculated involves a number of technical and intricate questions on which we shall doubtless hear something today, and into which I shall not go at this time. It is, however, clear that the existence of these stipulations does not tend to encourage the investment of the best and most permanent kind of capital. With the possibility of the wiping out of a large measure of the protection at present in effect, constantly in view, conservative capital looking for permanent investment will necessarily hesitate before committing itself to the support of the industry, and will leave the exploitation of the undertaking to the more undesirable and speculative kind of capital willing to take chances of quick and large returns during the period when such a condition exists.

Government Will Cooperate.

"The United States Tariff Commission has expressed the desire of co-operating closely with an authoritative trade organization representing the dyestuff industry as a whole, and I think we shall find that the representatives of the Commission who are with us today are quite prepared to give us all the encouragement we can expect that when the judgment of the trade is fully expressed, our interests will be safely guarded against unfair competition by those seeking to regain control of this market.

"The question of patents as affecting dyestuffs also is a matter of interest, and on this point also we shall have some information today from a gentleman who has made a close study of the question and is eminently qualified to speak on this subject.

"There will undoubtedly be other issues raised during this meeting which will, I hope, bring forth an exchange of opinion and which will be of benefit to our industry, but there is one question, not especially peculiar to our industry but which constitutes a distinct menace to our industrial life in many lines, on which I hope this convention will give some unmistakable expression of opinion—that of the use of bribery to effect sales, and to secure monopoly of control which otherwise would not be available. It has been distinctly and characteristically a German practice, and has prostituted the dyeing industry not only in this country but in all other industrial centres, Great Britain, France, Italy and Russia. It has been one of the insidious and pernicious methods by which the world-wide German domination of the dyestuff industry has been built up. While enlightened nations have been effecting legislation to eliminate unfair competition, it has eaten at the very root of the underlying idea, that of regulating the conditions of trade so that the small merchant may have an equal right of existence and to the profitable continuance of his business as the large merchant. It has been a festering sore, the more dangerous in that it has necessarily been secret and unseen, which calls for a drastic and ruthless application of the knife.

Must Take Firm Stand.

"It is not amenable to defence, and the only reasons for its continued existence are that there are some influences which see their own self-interest involved in its retention, or that we are too timid to recognize its existence and to take a firm stand on the side of right and justice. In that it cancels the reward of merit and frustrates the rightful development of true progress, it is unfair, unmoral and un-American, and the influence of this proposed association cannot be exrcised in any more righteous direction than in the destruction of this baneful disease which has been imposed on our industrial body.

"This, gentlemen, is a brief outline of the ideas which have actuated the calling of this convention, and I commend them to you with all reservation, and as being simply an individual expression of opinion, believing that the exercise of your good sense and business intelligence will work out a line of development which will make our new industry, created so successfully, and with such unparalleled promptness, a permanent and valuable asset of our industrial life, with the interests of all, both large and small, and whether manufacturer or dealer, properly and fairly considered and safeguarded against unfair discrimination and competition from any source either inside or outside our own ranks."

"If we are to take Mr. McKerrow's address step by step we would have to have a five day convention," declared Mr. Hemingway. "In view of the fact that our program itself provides plenty for the short time at our disposal I shall not make any introductory remarks except that I want to say in regard to the item on the program that the gentlemen who came together to talk over the general arrangements for this meeting today were a little at sea as to how to proceed, as to what arrangements to make toward a charter and by-laws, should you form an association. We were fortunate in getting Mr. Benjamin H. Kaye to help us. Mr. Kaye has had experience in this sort of work and has devoted several days of his time to lining up the general form of the association for us."

MR. KAYE ON ORGANIZATION.

"Mr. Hemingway has in a measure explained why I am here, but briefly the problem of association work is one that is always interesting to me. When Mr. Hemingway called me up and asked me if I could give a little time to the gentlemen who were interested in forming the association and I came up and attended the meetings, I heard the same line of complaints which I had heard in the other industries. There was the same talk of trade jealousies, mutual distrust. We had the same thing in the leather industry, we had in some degree the same thing in the disinfectant industry and yet a short time after the association was formed all those things were swept aside.

Success of Other Associations.

"One of the gentlemen at the meetings I attended last week scoffed at association work and said there are not many associations going anyhow. I have before me a report of the Department of Commerce on Commercial Organization, published in 1915, which gives five hundred national associations, aside from state associations and local associations. They cover practically every branch of industry with the exception of the dyestuff industry. I do not want to take time to summarize these associations because I take it for granted that by your attendance you are interested in association work.

"I have an illustration that may have some weight with you. When we formed the Disinfectant Association, we found a very strong distrust among a few of our Western people against the West Disinfecting Company. That is a very able organization with a well-established laboratory and well committed to the doctrine of the standardization of disinfectants. Some of our members took me aside and warned me against the West people. One of our members, after one year, who had been most outspoken against the West people came and asked me if I would seat him next to Mr. X. of the West Disinfecting Co. It was a case of two men who had had an opportunity in that year of sizing each other up and finding out what each other stood for and finally realizing that by standing together they were doing each other the most good and not harm.

Case of Dye Industry Urgent.

"If you come together you are going to find the same spirit in your entire industry, and, as Mr. Hemingway has said, great good will be accomplished by coming together and seeing and knowing each other and realizing that you are all members of a large association and that, while each man is determined to make his way in his business, he can best do that by co-operative effort with other men in the same industry.

"When the dyestuff matter was put before me I began to realize that of all the industries in this country the one that stood in most need of associated effort was the dyestuff industry. Not merely because it is a new organization, just starting, but because of the things which you will have to meet. Of course prominent in all our minds is the idea of German competition, and there, genelemen, you are meeting organized competition of the most potent type. Organized not merely in brains, but organized in government control and in activity, and, just as no single nation could stand up against Germany in the present war, no single manufacturer is going to stand up against German competition in the war for trade supremacy.

Insidious Propaganda.

"They are too well organized for that and you must organize to meet them. Their propaganda work is not only carefully planned, remarkably backed both financially and by brains, but also insidious in its workings. We know that they have practically government backing and government control. There are six leading German companies and seven smaller German companies. But theirs is an organization, and I am informed by Mr. McKerrow that there are already today in this country something like 130 manufacturers of dyestuffs. On the face of it, how is the disorganized effort of 130 concerns going to meet the organized effort of thirteen huge, active and well-established concerns?

"Then again you have the competition of the other nations, England, Switzerland, Sweden, Italy, Japan, all of them making a strong effort to get their hands into the dyestuff industry. It is only by associated effort that you are going to accomplish the saving of your own industry, not merely by the interchange of thought, but by government protection.

Obtaining Government Support.

"No single concern in this country can go down to Washington and have proper legislation passed to protect this industry. Apart from the difficulty of obtaining government support when it is suggested by one concern, you have the constant distrust at Washington that some individual concern is planning something for its own benefit, and even if you gentlemen were not aware of an effort being made, some Congressman or some Senator will ascertain that a bill has been pressed and backed by a certain concern and immediately everything is in confusion. But when you go to Washington as an association representing the entire industry, you receive the most courteous attention, a fair hearing and usually you accomplish your result.

Killing Ill-Advised Legislation.

"In the Disinfectant Association we received word that a bill had been railroaded through the Connecticut legislature providing for the putting of a final co-efficient number on all disinfectants. That is one of the steps toward standardization of disinfectants. Three years ago the members of the Association were opposed to that standardization, today they are in favor of it but realize the difficulties of establishing a definite standard. The bill as passed was very badly drawn. We were not opposed to the establishment of a final co-efficient law in Connecticut; we were opposed to putting a statute upon the books which would demoralize the industry.

"I got in touch with the sponsor for the bill and arranged to meet him. We met on the train; he, the man who proposed the bill, Mr. F. Walker, one of our members who discovered the bill, and myself. We took a compartment on the train and by the time we reached Hartford we had re-drafted the bill for him, with the result that though the bill had already passed both houses, it was withdrawn, and the bill which had been drawn by us was passed in its place. And today, while I realize it is not a perfect bill, it certainly covers the point infinitely better than the original one.

Application to the Dye Industry.

"The same thing will apply to you with the dyestuff industry. If it is a question of tariff changes; if it is a question of getting the government to see how closely you are allied with the munition industry, you will get a hearing as a body and not as an individual. I pointed out to the gentlemen of the committee that we must proceed very slowly, that it lay not in the power of a few men meeting last week, or in your power, in a quick and arbitrary manner to adopt a form of arbitration or a definite plan of propaganda work. An association is formed very much in the manner of the formation of the United States of America. There were a lot of colonies and they got together in 1776 and declared their independence, and then in 1776 they discussed Articles of Confederation, and from June, 1776, until February, 1781, these Articles of Confederation were first discussed and then gradually submitted to the various colonies for adoption. The Constitution of the United States was not adopted until 1787.

Method of Procedure.

"You must do about the same thing here. You are meeting not to declare your independence but your inter-dependence. Every man is privileged to get up and explain what his company does, and we want him to do it. The views of all the gentlemen present taken together and read over will form the body of thought upon which your organization committee will be enabled to work. I suggested to the meeting last week that your procedure should be a similar one to that of any other organization.

"At the meeting today, if possible before the close of your morning session, have your chairman appoint an organization committee, this committee to be limited to merely making out a statement of the purpose of your organization and a general plan of procedure. Then have your committee empowered to act as an organization committee only until your first annual meeting and by first annual meeting I do not mean a meeting a year from now but a meeting two or three months from now.

"During that interim your committee will be empowered to entertain and pass upon applications for membership. It will be in a position to consider the various topics of bylaws, etc., the question of classification of membership, dues, propositions for propaganda work, etc. And I also suggest that the Chairman of the organization Committee arrange for a series of committees selected from the manufacturers, on the various topics which have been discussed and will be discussed, such as registration of dyestuffs, standardization, arbitration of disputes, patent law, trade revision, propaganda work, and each one devoted to its own topic, and in the interval between this meeting and your first annual meeting, can lay the data upon which it may render a comprehensive and intelligent report. Upon the reports so rendered you can establish what will amount to your constitution, the principles for which the association will definitely stand.

"These are practically the only suggestions I want to lay before you. I desire if you have an organization committee appointed to have the opportunity of meeting with and advising with them and give them the benefit of whatever experience I have had.

Urges Against Delay.

"I just want to leave you one thought. No manufacturer in this country, especially in this industry, is big enough to dominate the United States in its legislative policy; nor is it big enough to dominate this industry. But if you keep on going ahead in your line, as 130 separate concerns, as soon as the war is over and your real competition commences, one by one you are going back to the wall. This is the time for you to form your association and not wait until the enemy is within your borders. We have learned our lesson in preparedness and having learned that lesson, I suggest that we prepare now."

ORGANIZATION DISCUSSED.

Following Mr. Kaye's address, which was well received, the dominating topic of the day, that of organization, was then brought to the fore when Mr. Hemingway announced a general discussion on this subject. After a few scattered remarks and suggestions from various parts of the hall, L. A. Ault, of Ault & Wiborg, Cincinnati, Ohio, precipitated a lively discussion when he gave utterance to an angle of the subject which evidently lay close to the hearts of all.

"It seems to me," declared Mr. Ault, "that this should be an association of manufacturers only. I should be pleased to hear what the gentlemen who discussed this convention last week think of it."

Dealers Want Place in Sun.

Chairman Hemingway said it was his understanding that the association was to be one of manufacturers and dealers in dyestuffs.

A dealer present stated his belief that it was in the minds of all that the prospective organization should be a commercial association that would bring in responsible manufacturers and dealers in dyestuffs and intermediates, and would include such dyestuffs as alizarin, turkey red oil, etc.

Elvin H. Killheffer declared, "I think manufacturers are in sympathy with Mr. Ault. Is this a meeting of manufacturers or a meeting of dealers? I think it is the feeling of many of the former that manufacturers and dealers have nothing in common. While it might be a commercial association in which the dealers might be a subsidiary part, there are a great many subjects which must properly be decided by those who actually make the dyestuffs."

Difficulty Was Foreseen.

This was evidently the solution which had been in the minds of those who planned the convention, for Chairman Hemingway declared that at the preliminary meetings, held the week previous, the feeling had been that when the organization committee was formed it would be composed largely of manufacturers, who would give their first thought to the question raised by Mr. Ault.

"It was felt," he continued, "that the final decision would be in favor of two classes of membership; Class A for manufacturers, and an associate membership for dealers. I do not wish to speak in advance, or suggest what the committee shall do, because the committee will be chosen from among you, but that. I think, is the big thing for you to decide."

Manufacturers Important, Says Dr. Matthews.

Dr. Matthews was emphatic in his belief that the organization should be primarily an organization of manufacturers.

"I had the privilege of sitting in at this meeting." said Dr. Matthews, "and the thought in the minds of these people, I believe, was that the problems which would arise in this association were chiefly manufacturers' problems, and consequently that the manufacturers had certain interests which probably were not associated directly with the dealer and with the consumer. Sensing the attitude in the minds of those representing the large manufacturers. I came to the conclusion that this organization, if going to be backed by the manufacturers, either large or small, would necessarily emphasize the manufacturing end of it.

"As you know, we discussed the probability of bringing forward the idea of two classes of membership. active and associate membership. The active members could consist of those who were actually manufacturers of dyestuffs, and the associate members should represent those who were interested in the allied trades, such as in the selling of dyestuffs, the manufacturing of machinery for use in dyestuff manufacture, etc.

"It might be patterned somewhat after the National Cotton Manufacturers' Association and various other trade organizations. If this is to be a trade organization, it has got to hold forward the idea that it represents the trade as a whole on related and unrelated problems.

"The idea that we had in view was that the emphasis should be laid on the manufacturers. That is the opinion. I think, of the principal manufacturers of dyestuffs, and an organization that would leave out the principal manufacturers of dyestuffs I do not think will get very far in developing the industry. We had a strong note of Americanism. It is in its infancy now, and has not yet grown to the vast proportions which many people abroad think it has. It needs care and guidance.

"There are many problems regarding manufacturing which this organization can handle: the relation to the Tariff Commission, the distribution of raw materials for the manufacture of dyestuffs, etc., the say-so as to who shall use this or that or the other thing. If that matter is unrelated and not harmonized by any organization which will co-operate among the different manufacturers to settle questions as to who will get this and who will get that, the small manufacturer will be left out and the big manufacturer will get more than he really should have. The thing is that the organization should be primarily an organization of manufacturers.

Why English Failed to Organize.

"If you will refer back to the dyestuff industry in England," continued Dr. Matthews, "you will find that there were a lot of broken-up efforts toward making dyestuffs, and what was the result? It died a natural death because of the lack of co-operation in dealing with manufacturers' problems. When the Germans took hold, they started to organize and co-operate. The number of manufacturers has narrowed down to a small number, and by their size and co-operation they can do things which a lot of disorganized manufacturers cannot do.

"We are at the same place as when England first started. We have a hundred or more manufacturers. People are duplicating their efforts. losing a lot of energy and capital through not co-ordinating their experience, capital or efforts. If we do not do something toward co-ordination, when the war stops and normal conditions return. we will be up against a strong organization. I think that in the minds of those who acted in this little committee was the thought that the problem was a manufacturing problem primarily.

Must Agree or Fail.

"Now, if this convention takes and runs away on the other side, I am afraid that the effort will be in vain: that the large manufacturers, or what you might term the bona fide manufacturers. will look with askance at an organization that will not deal with manufacturing problems, but will deal with commercial problems."

Dividing Line Hazy, Says Dr. Pierce.

Dr. Pierce wanted to know just how the two proposed classes of members should be separated. "There is no sharp dividing line between dealers and manufacturers," he said. "Would you exclude the manufacturers who made twenty-five colors and also made some glue as a by-product? If there was a small factory which made two colors, and likewise bought and sold dyes, they would be a manufacturer in one sense of the word, and some of the large manufacturers would be dealers."

Mr. Chapin suggested that this might be determined by the arbitrary selection of a certain number of standard products, and then passing a rule that all manufacturers must prove that they are making this number of colors before they could be classed as manufacturers.

Manufacturers Only, Thinks L. A. Ault.

Pursuing his original subject, Mr. Ault said: "I would like to call this to your attention: What is the opinion of the dealer worth, compared with that of the manufacturer? He has no interest in the manufacturer. I cannot conceive why I should get sympathy or worry because of lack of sympathy from a dealer. The dealer buys his goods anywhere he pleases, and is not interested in the welfare of any particular manufacturer. A man should be a manufacturer—or he should not be in the organization."

Considerable stir followed this remark, and it was not until Mr. Kaye quoted Mr. Poucher, of the Du Pont Company, as being in favor of recognizing the interests of dealers, that the heated controversy was finally lulled. According to Mr. Kaye, the Du Pont representative expressed himself as follows:

"Our one underlying idea is to keep the manufacture of dyestuffs in America. The dealer has this interest in common with the manufacturer. Another important point to remember is that if you went down to Washington in an endeavor to have legislation passed, you would probably get more consideration if you represented 700 firms instead of only 100."

Dealers Withdraw Temporarily.

Seeing that the chances of an amicable agreement were apparently as far away as ever, B. P. Donnelly, of the Holland Aniline Co., Holland, Mich., came to the rescue with the suggestion that the two interests hold separate meetings to talk things over by themselves. The opportunity was eagerly grasped, and after a census revealed that the dealers present were greatly in the minority, they withdrew from the hall to meet in another room in the building, leaving the manufacturers in full possession of the field.

Status of Foreign Interests.

Before taking up the question of the dealers' status, the manufacturers, after the doors were closed, considered the attitude which should be taken with regard to foreign manufacturers of dyestuffs. As a corollary to this, Dr. I. V. Stanley Stanislaus, president of the Stanley Aniline & Chemical Works, Lockhaven, Pa., thought that the status of American manufacturers located in America, and owned by foreign interests, should also be decided.

A. Brooking Davis averred that some foreign manufacturers have larger interests than the domestic. "Why should they be excluded from this organization?" he queried. "Their co-operation would be valuable."

Other matters for consideration brought forward were plants controlled by American interests but having an intrest in the country of an alien enemy, and American manufacturers with foreign agencies.

Favor Pan-American Organization.

The general sentiment, however, seemed to be in favor of making the organization Pan-American as to membership, with possible relations with foreign organizations of a similar character whenever it might seem advantageous; and also to make the bona fide manufacturers the foundaton and principal substance of the organization. Put into concrete form, these decisions were finally presented to the meeting of manufacturers as resolutions, which were unanimously passed in the following form:

> RESOLVED: That there be organized an American Association of Dyestuff Manufacturers, composed of American manufacturers of dyestuffs, financed with American money and located in America, for the protection of the American industry of the future, and be it further
>
> RESOLVED: That this organization shall consist of two classes of membership; active members, who will have voting privileges and shall consist of manufacturers of dyestuffs and intermediates; and associate members, who shall not have a vote, and who shall consist of dealers or distributors, or manufacturers of co-related products used in the dyestuff industry.

Mr. McKerrow in Role of Hermes.

Following the enthusiastic passing of these resolutions, Mr. McKerrow was delegated to convey the decision regarding membership to the dealers' body meeting in separate session.

David W. Jayne, of the Barrett Company, then expressed his hope that the new organization might become a part of the Chemical Alliance, which was formerly the Chemical Committee of the Council of National Defense formed shortly after the outbreak of the war.

JAYNE ON CHEMICAL ALLIANCE.

"If you have a broad organization of dyestuff manufacturers you are going to be interested in the so-called Chemical Alliance," declared Mr. Jayne. "The Council of National Defence appointed a lot of advisory committees last spring, one being the Chemical Committee, expected to do a certain piece of work, but being merely a committee it could not handle it, and therefore they organized and incorporated the Chemical Alliance. This fall, when the Council's committees were put out of existence, the Chemical Alliance was brought forward as a substitute for the Chemical Committee of the

Council. They did not want the chemical industry disintegrated. There had been some very good results from cooperation with manufacturers, and anything that you could suggest as an organization to keep the chemical trade together will be of advantage to the nation.

"We put forward this Chemical Alliance as a solution of the problem. It is constituted of sections of the chemical industry and at the present time we have the following sections: Acids, coal-tar by-products, foreign pyrites, fertilizers, alkalis, domestic pyrites, sulfur, etc.

Dyestuffs Should Be Represented.

"I feel that the dyestuff manufacturers ought to be represented by a section in this Alliance, and at the December meeting I got permission to approach the dyestuff trade and see if it would not join the Chemical Alliance.

"I hope that we are going to get a dyestuff section of the Chemical Alliance. The principal point regarding membership is that you must be a manufacturer in that section. Dealers are not considered ordinarily in government cooperation, and I think that it is a thing which every dyestuff manufacturer, as a user of all these other chemicals, must certainly be interested in.

"You can easily see that every dyestuff manufacturer uses acids, alkalis, etc., and being associated in the Chemical Alliance must bring you more in contact and enable you to present your requirements to the government in connection with the well-known situation in acids and alkalis, much more satisfactorily than if you were an outside group, and I think that all of the members ought to belong to the Chemical Alliance."

Dealers Want Further Parley.

Scarcely had Mr. Jayne concluded his remarks when, amid an expectant hush, Mr. McKerrow returned from his conference with the dealers. He said that he had reported the manufacturers' decision to the dealers.

"But they feel that there are certain aspects of this question," he announced, "which have not been gone into as fully and fairly as they should be, and they suggest that you appoint a small committee from your number to meet a small committee from their number to discuss these matters and report back to the convention later."

Dr. Matthews, Mr. Merz and Mr. Ault were thereupon appointed to confer with the dealers' committee, consisting of Mr. Webster, Mr. Hollywood and Mr. Beatty, and the session was adjourned for the morning.

DR. PIERCE ON STANDARDIZATION.

The afternoon session opened with the two committees still in conference. The first address scheduled was that of Dr. Edward Wallace Pierce, of the U. S. Conditioning and Testing Laboratories, New York, and proved to be one of the most important contributions to the convention. Dr. Pierce spoke on the question of dye standardization, which he declared to be perfectly feasible, and proceeded to show just how this problem might be approached.

Ultra Violet Color Testing.

He called attention to the excellent results obtained through the use of ultra violet light for color testing and explained the advantages of this method over the use of sunlight from the standpoint of time-saving and uniformity. He also told of the activities of the U. S. Bureau of Standards, and urged that the manufacturers take speedy action towards establishing a standard in order to forestall the inevitable and possibly more drastic regulation from Washington. Dr. Pierce's address, together with several interpolations, follows in full:

"A form of standardization is possible and is being applied at the present time," said the speaker. "All that needs to be done is to adapt it to the needs of this association. I have prepared a few remarks on the subject.

"While the majority of events which have culminated in this convention have had their inception since the beginning of the war, this question of testing and standardization goes back to the very origin of coal-tar dyestuffs. It is now over twenty years since I first began testing, classifying and attempting to standardize dyes, and with your permission I will try to outline the difficulties and possibilities, in order to see whether we cannot, at this time, take steps to adopt some uniform system that will, at the same time, be acceptable to both consumer and producer.

How Germany Maintained Standards.

"Before the war, all my work was done in the interest of a branch office of what was then, and is now, the largest American dyestuff factory. No one who had not been through the ordeal could picture the difficulties of holding out against the German competition of those days, but it can be readily understood that business was only possible by being able to supply goods of as high quality and rendering as efficient service as our foreign competitors. The standards of those days were set by the large German factories, and it is said that there was between them a free interchange of type samples in order to maintain a certain uniformity in shade and strength of dyes made in the various plants. These standards were created arbitrarily, as we see in the case of such dyes as Rhodamine-B, which was only 20% of its full strength; Chrysophenine, which was 40%; Chinoline yellow 20%; Auramine II 33 1/3% of Auramine O, which, in turn, was 75% less than the pure dye. The list might be prolonged to great length, but the facts are generally known.

Samples Must Not Be Best Quality.

"Now it is not only permissible, but an actual necessity, for a factory to have a sample for commercial purposes which is somewhat below its best possible production; otherwise it would be burdened with large quantities of dye below standard, because no factory, no matter how high its efficiency, can turn out every lot perfect. This point will always be insisted upon by the manufacturers and conceded by the consumers. A second class arises in cases where the factory batch is not simply below strength, but is off shade and requires some other dye to be added to bring it to type shade. A third class is deficient in brilliancy or solubility and can never be made right by mixing other color with it. These manufacturing problems are the cause of all the arguments concerning standardization. Of course we must consider deliberate adulterations and substitutes, but as these are so easy to detect they constitute no real problem.

"Every factory worthy of the name maintains its testing department, and is fully aware of the deficiencies in each lot of dye produced. Corrections are made and the lot brought up to the factory standard if possible. Extra strong batches are mixed with weak ones and different off-shades are mixed to correct each other, outside colors only being added when there is no other remedy.

Some Testing Methods Employed.

"The methods of testing dyes are generally known to chemists who have specialized in such work, but, unfortunately, there has been no definite rule, and each operator uses whatever methods he deems best. In the case of comparison of two samples of identically the same dye we may use a colorimetric method. In all such tests equal quantities of the dyes are dissolved in equal quantities of water and the relative depths of color of the solutions measured either in Nessler jars or cylinders, or more accurately in a colorimeter of the Campbell-Hurley type, and for very exact work in the Kobel colorimeter. Whether the two samples are identical in composition or not can be determined quickly and accurately by observation through a small direct-vision spectroscope and the identity of any other additions established by consulting the tables compiled by Formanek.

"I have been criticized for using the colorimetric test. There is one drawback about the colorimetric method which is also a drawback about others. No attention is paid to the amount of mixture present.

"If the two dyes are not of absolutely the same nature, the colorimetric test is of no value and we must depend on comparative dye tests. In the comparative dye test it is always essential that both dyes be applied in their proper manner under exactly the same conditions. Slight differences of time, strength of both, temperature, etc., have great influence on the value of the test. Samples dyed at different times are never to be considered as comparative. While the colorimetric methods are accurate within 2% or less, the comparative dyeing is not effective for differences of less than 5%. This is due principally to the inability of the eye to distinguish on dyed fabrics as closely as in the instruments.

Ultra Violet Rays for Dye Testing.

"The means of testing for mixtures and the material used for reduction are simple operations, and by the use of the microscope can be made to give dependable results. The methods of testing for fastness to different influences are more varied, and while the U. S. Government has specifications for dyed materials, there needs to be an American series of tests that will be uniform.

"The Government demands that a sample shall stand thirty days' exposure to the sun. In July, when you have clear days every day, it is one thing, but thirty days' exposure to the sun in January and February is an entirely different thing. And the goods must always stand up as well as a certain sample which the Government will supply. We are bringing forward the ultra violet test for dyes, giving them forty-eight hours' exposure to the ultra violet light. Sometimes slightly different changes take place in colors that do not take place in the sunlight.

"The ultra violet lamp has been extensively used for tests for fastness to light, but at present we need a scale of fastness that will mean more than the terms used at present—one that will express in hours or days how long any given percentage of dye will resist. This can be done, and, whether this association endorses such work or not, it will be carried on independently.

"The ultra violet light gives off an assortment of rays. Some of them are invisible. The action of ultra violet light, as soon as the apparatus is started, is indicated by the smell of ozone in the air. There is only one way to bleach linen properly; spread it out on the grass, sprinkle it with water and expose it to the sun. That is not an ultra violet action. It is a genuine oxidation of the coloring matter of the fibre. This is the difference between sunlight and ultra violet exposure. There is no moisture present in ultra violet exposure. When we say a color is fast, moderately fast, very fast, or not fast, we are able to express that it will stand a certain number of hours' exposure without changing.

What Dye Standardization Means.

"Standardization is one of the burning questions before this meeting. On it hinges the question of whether certain producers will join or stay out. There seems to be a slight misconception of the meaning of the word. A recent article by Mr. McKerrow spoke of the standardization of the names of colors so that we would have a rigid arbitrary shade to represent each fancy color and a universal use of such standards. This very thing has been most admirably covered by the Textile Color Card Association, and while most useful and commendable, is an entirely different problem from the one before us.

Will Please Consumers of Dyes.

"A standard is not an ideal—it is a unit or system of measurement. Before the war, the German factories had standards of their own making, and today we can have American standards of our own making. We already know how to measure and appraise these goods. We want every manufacturer to make for himself a type or standard of each of his dyes and put these on record, as it were, by depositing samples in the hands of a dependable custodian. From these samples portions can be issued to those interested in testing, and the manufacturer will obligate himself to make deliveries equal to the type he himself established. Probably when several factories are making the same dye, it will be possible to bring about a uniform standard between them which will really be a great convenience to those you must seek to please—your customers. This will work no hardship nor restriction on anyone, except on the manufacturer who delivers second-grade goods when he has agreed to furnish first-grade.

"No honest manufacturer has anything to fear from such supervision, and further, if it is not done voluntarily by this association, it will be done by other and more critical authorities.

U. S. Bureau of Standards Already at Work.

"The Bureau of Standards, at the instigation of the Federal Trade Commission, is at work along such lines at the present time. The institution I have the honor to represent is doing this work now in the interests of consumer, dealer, exporter, or whoever desires to know the truth. Our success has been partly due to the fact that, on account of such long association with the selling end of the dye business, there is not that danger of my taking the narrow-minded view that characterizes the reformer or purely scientific investigator. Your troubles are known and your critics and competitors are known, so that our efforts are always toward effecting a better understanding rather than fostering a controversy.

Forestall Future Foreign Competition.

"These things are quite possible under your own supervision and thereby you can forestall the more severe supervision of Washington. The only obstacle that can be foreseen is the disinclination of certain manufacturers to obligate themselves to make uniform deliveries. This is a measure of preparedness for the competition which is to follow the war. Before the war the Germans set the pace for us to follow—let us set up a standard of our own and insist on clean, open business methods, and defeat their effort to get this businass away from us again."

CHAPIN ON BY-PRODUCTS.

Dr. Pierce was followed by Mr. Chapin, who pointed out the conservation which could be brought about through co-operation in the sale of by-products resulting from the manufacture of dyestuffs.

"I have two subjects that came into my mind that have not yet been presented—two subjects which I think could rightly form the scope of a dyestuff association. The first is the matter of preventing needless duplication of effort.

Needless Duplication of Effort.

"In my work as consulting chemist for the trade, I have become more or less familiar with the colors that are being manufactured, and of the needs of the trade, and I find a great many similar colors being produced by numerous concerns. It has occurred to me that one of the intentions of this association might be to act as a sort of medium by which the field could be divided up.

"There are many dyestuffs which are most difficult to make, that are needed by the trade, and needed very badly. I was talking with the purchasing agent of a large mill recently and he said, 'I have had hundreds of such colors as fast red, etc., but it is impossible for me to get certain colors which I need in my business,' and I think that this has been and is the condition which we face, and an exact report by such an association could act as a means by which different concerns could be helped and steered to certain fields in which their efforts would lead to the best result.

Utilization of By-Products.

"There is another point which has come to my mind, and that is that such an association could act as a means for the utilization of by-products. As you know, the dyestuff industry produces a host of by-products. You may be making one color and getting a by-product which could be worked up with more apparatus. This by-product piles up, and if one can find a market for it, it is an added source of revenue, and it frequently happens that such a by-product may be the raw material that somebody needs.

"These are the two aspects which have appealed to me very strongly because I think they are two features which, if worked out, would react to the good of the industry in this country."

Agreement on Membership Reached.

The joint committees of manufacturers and dealers then returned to the hall, and Dr. Matthews, who acted as their spokesman, reported that a full agreement had been reached. The decision differed from the original resolution passed by the manufacturers in that it provided that the dealers should have a representative in the governing body of the association and that the admission of any firm to associate membership should be passed upon by a committee consisting solely of associate members.

Dr. Matthews' words were:

"The committee has come to the understanding that: There are to be two classes of members: first.

the active members, consisting of dyestuff manufacturers who will be those who are entitled to vote; second, a class of associate members, the dealers and makers of machinery or other allied industries.

"That the associate members are to have a representative on the Board of Governors, or Executive Committee, or whatever that committee may be which will direct the business affairs of the organization.

"Secondly, that the membership qualifications of associate members be determined by a committee of associate members. The associate members feel that their membership should be scrutinized by them. Associate members are to be properly represented on arbitration."

Vote to Organize.

These revised terms were received with enthusiastic applause, and without further ado Mr. McKerrow put the motion for organization on the grounds just stated, which was promptly seconded by Dr. Stanislaus and, amid additional applause, was passed unanimously.

This closed all discussion for the day, and the Organization Committee, headed by Dr. Matthews and consisting of Messrs. McKerrow, Ault, Merz, Woodward, Hyndeman and David, was appointed to effect the details of organization. The balance of the afternoon session was spent in listening to the addresses of Dr. Matthews, Albert E. Parker and Bradford Webster, which follow.

DR. MATTHEWS' ADDRESS.

"What objects this organization has, I think, have been pretty well brought forward in our preliminary discussion. The main idea is that we shall establish and maintain a dyestuff industry in America. That is the proposition we must always keep before us.

Time Not Ripe for Increased Duty.

"As to the objects secondary to that, we have many and diverse ones. First, the relations of the industry with the Government, particularly in regard to the tariff law. As you know, we have already a dyestuff tariff, seen through very largely by the consumers of dyestuff in this country. I do not know of any other example in tariff legislation that showed a condition of affairs where the consumer of the product stood back of the manufacturer and helped to get legislation through. We have to consider that bill as it stands. Those familiar with the present tariff bill know that it has certain incongruities and certain obstacles which should be met in the proper interpretation and carrying out of that bill. Unless these obstacles are taken out, the tariff bill will not come up to the expectations that we have entertained. The Tariff Commission which has been appointed to deal with tariff problems is working on this proposition, and as I understand it, they are waiting for us as an organization to formulate something in connection with their own ideas and with their own work, so that a just and equitable solution of these obstacles may be made. One of the first things to go up before this organization is the question of a proper representative committee which will study out this tariff proposition and meet with the Tariff Commission and give it the needed co-operation and aid. I do not feel at the present time that we are justified in yelling for a higher rate tariff.

"Suppose we take the bill as it stands and try to justify it by smoothing out the obstacles. Probably a new bill will have to be drafted in order to do this. But it should not be our purpose to bring forward our selfish ends. Let us take the tariff rates as they stand and try to co-operate with the Government and with the Tariff Commission, in order to make that bill a proper working basis, and something which will be of benefit to us and to the Government.

Should Cooperate with Government.

"In the second place we have our relations with the Government at the present time, which is very important. As you know, the Government is controlling the raw materials; for instance, it is distributing these materials on the basis of war conditions, and the dyestuff manufacturer needs many of these materials to carry on his business. This question should not be gone into in a selfish way. We should realize that our Government has certain needs and that we must sacrifice if it comes to a show-down. We should have a committee which should co-operate with the Government in the distribution of raw material.

"Because the Government officials are not always well educated into just what materials are needed, we should have a committee which should deal with these problems in a spirit of patriotism and consider the ends of the Government as well as the manufacturers.

Unfair Competition.

"In the third place we have another relation to the Government and that is in the question of unfair competition. As you know, we have a variety of laws on unfair competition. The dyestuff industry should start out right, and start out with an ideal ahead of it that is going to eliminate unfair competition. We have had it in the manner in which the German houses did business over here. In some cases the dyestuff business was looked upon with askance. The men in the dyestuff business were supposed to be highbinders and grafters.

"We want clean business if we want any at all, and I think it is American principle to have a clean business. We do not want to do anything that is not proper, equitable and just in a business sense. Nothing shall creep into it that is not truly American in spirit and clean in business methods. Otherwise we are bound to clash with the Government.

Some Causes of Disputes.

"Now we have other things in view, unrelated to the Government but related to the community, and this brings us to the question of the amicable settle-ment of disputes. Probably there are a great many just causes of dispute from buyers of dyestuffs and consumers who do not always watch the material they buy as closely as they should. As a general proposition you might think that people buy mostly by sample and if delivery is not up to the sample it should be rejected. There are many points which come into play which do not show on the surface. The manufacturer or dealer may be perfectly square and the consumer may be equally square, but the object of an arbitration board would be to study these problems intelligently in order to arrive at a just judgment. There are many problems coming up relating to manufacturer and consumer which can be dealt with by arbitration without going to a law court.

Good Fellowship.

"There are other things with regard to our relation to the community, and one is the relation to our good fellowship toward each other. Most organizations of this type build a great deal on the power of good fellowship. If everybody goes into his own corner we will have jealousies which work to the destruction of the business rather than to the upbuilding. You cannot be an enemy very well with a man you can sit down and chat with, and take dinner or smoke a cigar with, and these things will help a great deal in the smoothing out of many difficulties. Sit down face to face with a man and discuss a thing, and many of the great objections will melt away and we will get the same point of agreement as we did with our meeting of the committee. All this will make for a benefit to the trade.

Why Manufacturers Should Control.

"The reason the manufacturers have emphasized their controlling end of the affair was not a question of lack of co-operation with the dealer, but was based upon an economic principle. The problems which this organization has to deal with are chiefly manufacturers' problems. It is not a question of not being in sympathy with or co-operating with the dealer, or with the other allied industries; it is rather a question of the business end of the organization being conducted by those who know the technical requirements and the technical points, and they have the knowledge to meet the various problems which arise, and it would have been foolish to have an organization of this character start without the co-operation, without the support, of the dyestuff manufacturers. It would have been a mere shell and would not have gotten anywhere. I think in the little report we have made on this matter that we have been probably as fair as possible in meeting the requirements both of the dealer and the manufacturer.

"As to the personal features of any manufacturer's business, I do not think it is the business of this organization, or of any organization of dealers, to interfere with a man's business. We can only deal with those problems which affect the industry as a whole. And if the question comes up, for instance, of the selling of dyestuffs by one person to another, it is none of our business whether Mr. A. wants to sell to Mr. B., or not. But if some broad proposition comes up which affects the whole industry, like the tariff question, or the formation of associations, the distribution of raw materials through the industry as a whole, why then, unless we have complete co-operation, we will not get any great benefits in pushing this to the front."

ALBERT E. PARKER ON PATENTS.

"The American patent situation is commented on in the annual financial review of a leading New York banker as follows," said Mr. Parker.

> "'The miraculous growth of a great commercial industry should not be overlooked. Since the war $320,000,000 were invested in new chemical ventures in this country. A considerable part of this sum was for the manufacture of explosives, but much of it has been applied to chemical and dye plants, which will become a prominent factor in American industry. This industry means another big loss to Germany and has still to face a critical period when calm conditions return. German competition in dyes after the war will unquestionably be severe, and probably Congress will be asked to grant help to the industry.'

"For more than two and a half years before the United States entered the war American manufacturers in all lines of industry were placed in a disadvantageous position in the matter of the use of many important inventions in the industries concerned, as compared with the citizens or subjects of the countries with which we are now allied, by reason of the fact that after the war commenced in 1914 most of the European nations passed legislation under which the manufacturers in those countries could secure licenses at low royalties for the use of inventions which had been successful in enemy countries, but which by reason of the war could no longer be used in the countries of our Allies, due to the fact that they were owned by the enemy.

"The legislation which was passed in 1914 permitted the use of these inventions so as to bring about the continued supply of the product, and the manufacturers therefore were able to fill practically all the needs for articles which had formerly been imported or which in some cases had been manufactured in these countries after payment of substantial royalties to foreign patentees.

"Many reports were circulated that all patents owned by enemies in Great Britain were to be confiscated for the benefit of British manufacturers and it was freely stated that English manufacturers might then be free to make any article in Great Britain covered by enemy patents with sanction and authority and without payment of any consideration for that which was to be manufactured.

No Truth in Statement.

"There was no shadow of truth to this statement, which action would, of course, amount to confiscation. In introducing legislation into the English Parliament, the president of the Board of Trade made it abundantly clear that no confiscation was intended, but that the measure was intended to benefit British industries, while providing proper and reasonable means of compensating the owner of the patent if at the end of the war it were found that the German and Austrian governments would provide similar payments for British subjects owning patents in those countries."

Mr. Parker also stated that the Federal Trade Commission was now granting similar privileges under the Enemy Trading Act to American manufacturers and that licenses have already been granted for making articles covered by 60 enemy patents. He regarded these as of utmost promise for American dye producers.

MR. WEBSTER'S ADDRESS.

"The situation in the dyestuff industry is more complicated, perhaps, than in any industry in the world. In the first place, in 1915, the textile industry and other principal consumers of dyes were loaded up with all kinds of dyestuffs. When the war broke out, they had bought high-grade imported dyes under ordinary conditions; they bought dyes that had been intended for other markets, and mixtures compounded ignorantly. These conditions were a prolific source of trouble, and disputes were frequent.

"It was my opinion that probably the greatest service that Mr. McKerrow mentioned would be to bring about a powerful Board of Arbitration to settle these disputes. The courts are less adaptable to changing conditions of business than almost any other branch of the government, and with the profession of law one hundred years or more behind the profession of business it is natural that the effort to deal with the situation as it exists in the dyestuff industry today should be a failure. I know of one single case where substantial injustice was dealt out in the regular channels of a court of justice.

Arbitration Board Should Be Powerful.

"Therefore I believe that there should be a Board of Arbitration in this Association and it should have some power, and the more power that Board of Arbitration has the greater service it can render. A Board of Arbitration should see to it that any question which may be arbitrated before that Board shall be as enforceable as the verdict of a court of law. The Board should have a man with law experience, a man with manufacturing experience and a man with merchandising experience. One man cannot have experience in all these fields, but the man should have as much experience as it is possible to obtain and a broad sense of justice and fairness. The Board in my mind should be composed of three men. A Board of this kind should operate under a special set of rules or statement of principles and rules of procedure that are based on experience with disputes in the industry."

Discuss Tariff Law.

The convention opened Wednesday morning with Mr. Jayne in the chair. The principal address was delivered by Dr. Grinnell Jones, of the U. S. Tariff Commission, who made a strong plea for aid in the collecting of data which would assist the commission in formulating plans for a tariff which would insure a full measure of protection for the American dye industry after the war is over.

DR. JONES ON DYE TARIFF.

"It is not necessary before this audience to discuss the history of the tariff law of September 5, 1916, which raised the duty on dyes and other coal-tar products. I shall merely remind you that the legislation creating the United States Tariff Commission forms a part of this same bill. This law charges the Tariff Commission with the duty of gathering the facts needed for the consideration of questions of tariff policy and requires that all information at its command shall be put at the disposal of the President and Congress, whenever requested. The Commission recognizes that the dyestuff industry presents one of the most important and complex problems which it will have to consider, and is planning to make a report to Congress on this industry.

Commission Seeking Information.

"Last August the Commission sent a questionnaire to many of the leading textile mills asking for a statement in regard to the effect of the dyestuff shortage of 1915 on their business and the extent to which their needs have been met by the growth of the American dyestuff industry. These consumers were also asked to give certain statistical information bearing on the question and to state their opinion in regard to the wisest policy for the country to adopt on the question of the tariff on dyes. Returns have been received from seventy-seven textile manufacturers, and a summarized statement of the replies will be published very soon. The Commission is now seeking information from the manufacturers of dyes, intermediates, and other coal-tar products.

The Underwood Law.

"The Underwood tariff law levied an import duty of 30 per cent ad valorem on dyes, except indigo, alizarin, and dyes derived from anthracene and carbazol, which were on the free list. The act of September 5, 1916, placed an additional duty of 5 cents per pound on the dyes formerly dutiable at 10 per cent ad valorem, and imposed a duty of 30 per cent upon the dyes formerly on the free list. By the same act coal-tar crudes were put on the free list and intermediates were made dutiable at 15 per cent plus 2½ cents per pound. These specified duties of 5 cents in the case of dyes and certain other finished products, and 3 1/3 cents in the case of intermediates, were called special duties.

"The law further provides that these special duties shall remain in force only 5 years, and that they shall thereafter be gradually reduced by one-fifth annually. The law, however, contains another provision, which reads as follows: . . . . 'But if, at the expiration of five years from the date of passage of this Act, the President finds that there is not being manufactured or produced within the United States as much as sixty per centum in value of the domestic consumption of the articles mentioned in Groups II and III (intermediates and finished products) of section five hundred, he shall by proclamation so declare; thereupon the special duties imposed by this section on such articles shall no longer be assessed, levied, or collected.'

"The President of the United States has requested the Tariff Commission to ascertain the facts on which executive action under this clause must be based. It has seemed wise not to wait for the expiration of the five year period before beginning a systematic study of the development and progress of this industry in the United States.

"The schedule which has recently been sent to all manufacturers known to us is designed to ascertain the facts needed for the application of the 60 per cent clause, as well as to secure certain other information which will be helpful to the Commission and Congress in determining the wisest future policy. The Commission is taking a census of the coal-tar products for the year 1917, asking for the quality and value of the production of each intermediate, dye, or other finished product.

"It is, of course, well known in a general way to those familiar with the dye industry that the development of indigo, alizarin, and the vat dyes derived from anthraquinone and carbazol has not kept pace with the development of the azo dyes. Since these branches of the industry are the very important ones which, under the present law, do not get the benefit of the special duty of 5 cents, it is of great importance that the Commission have for the consideration of Congress definite statistical information in regard to the development of the different branches of the industry. For this and other reasons we are asking for detailed information in regard to the production of each separate dye, not simply for grand totals. We hope to publish the totals in as great detail as can be done without revealing the operations of individual concerns. For example, in the cases of aniline and Bismarck Brown there will be so many producers that the total production for the country can be published without revealing the operations of any individual concern.

"It is believed that this information will be of interest and value, not only to Congress, but to the producers themselves. In many other cases the publication of the totals would reveal the operations of individual concerns. In all such cases the dye or intermediate in question will be grouped with others of a similar character, so as to cover effectually the details. In the case of dyes sold under a trade name, whose chemical nature is kept as a trade secret, we are asking that you give us confidentially sufficient information in broad, general terms, such as will enable us to classify properly each such dye. It is especially important that we be able to distinguish clearly between dyes dutiable at 30 per cent. plus 5 cents per pound and those dutiable at 30 per cent. only.

"You will notice that under the present law it is necessary to ascertain both production and consumption of dyes in the United States. It would be impossible to secure complete returns from consumers themselves. It therefore becomes necessary to regard the consumption in the United States as equivalent to the sales of American manufacturers plus imports minus exports. Although the law requires a comparison of the value of the domestic consumption and production, we are asking for the quantity also as a check on the values, and because the quantity is for many purposes a better indication of the growth of the industry than the value.

"One of the difficulties which we foresee is the lack of a generally accepted standard of quality and strength for dyes. If as a result of the deliberations of this Association a generally recognized standard is adopted, the future work of the Commission will be greatly facilitated.

"We appreciate that it will not be easy to bring together the information called for on the schedule, but rely with confidence on the co-operation of the industry toward enabling the Commission and Congress to deal intelligently with an important public question. Although we have sought and secured the helpful co-operation of a number of representative manufacturers, both large and small, in the preparation of this schedule, we realize that it is capable of improvement. We ask you to do the best you can to supply the information in the form called for this year. We shall welcome constructive criticism which will help us to prepare a better schedule for later use. In making suggestions a clear distinction should be drawn between changes which can be made under the present law and changes which would require an amendment to the law.

"The work which the Commission is doing on the special law of September 5, 1916, is not confined to the questionnaire just described. We are also considering very carefully the possibility of improving the law by amendments.

"For example, the new act does not repeal all of the provisions of the old law which are in conflict with the intent of the new law. The list of intermediates mentioned by name is capable of such improvement. Such important intermediates as Michler's ketone and dinitrophenol are not mentioned, whereas the relatively much less important nitrotoluylenediamin and monochlorphthalic acid are included. Very little attention appears to have been paid to intermediates for medicinals or photographic chemicals or flavors. Many suggestions have been made to the Commission in regard to changes in the wording of the law. We have prepared a list of such of these suggestions as seem worthy of serious consideration. We will send a copy of this list to anyone who cares to offer evidence or opinion in regard to the advisability of the proposed changes, and will welcome any additional suggestions.

"The Commission will be glad to arrange for a conference with representatives of the dye industry in the near future. If such a conference appears to be desirable, the Commission will be glad to confer with the officers of this Association, or with any special committee appointed for the purpose of making all necessary plans and arrangements."

TARIFF DISCUSSION.

Leaks in Present Law.

In the discussion which followed, A. Brooking Davis declared that, under the present tariff law, he could not see anything to prevent the German color makers from bringing in certain leuco-dyestuffs as intermediates, and stated that the term "intermediate" should be most specifically defined in the wording of the law in order to make it effective.

"Revision Upward."

"In regard to the question as to the advisability of placing tariff on certain dyestuffs," he continued, "I believe that there are certain groups of dyestuffs and intermediates which are much more difficult to manufacture than others, that it is going to take American manufacturers a longer time to get into the manufacture of, and the tariff should be at least two or three or four times as great on these dyestuffs as on other series."

Referring to the exemption of indigoid dyestuffs, he said: "That statement of indigoid dyestuffs properly includes certain members of four distinct series, which are probably the most important of all the dyestuffs we need. I refer to indanththrene, alizarin proper, the indigo series and the carbazols.

"American manufacturers are not producing these in any quantity. They are going to be most difficult to produce. The production is going to need an investment of many millions, probably greater than all other dyestuffs put together, and it is going to take longer time to work out this group. It would, therefore, appear that a tariff placed on these dyestuffs should be much higher than on all other series, and I think it would be well to include the four distinct series, although they may somewhat overlap each other.

Must Define "Intermediate."

"Why should the law of intermediates be worded so that the tariff is actually retarded for a period of years? If the tariff is removed from intermediates, it permits our competitors to bring intermediates in here and make the dyestuffs in this country and thus avoid paying duty. What is an intermediate? A German concern could manufacture their own dimethylaniline, their own phosgene gas abroad and ship it into this country, convert into dye when it got here by condensing with a simple napthol sulfonic acid and avoid the tariff on Victoria blue.

"We should make a specific definition of an intermediate. How far can a product be advanced in process before it ceases to be an intermediate? What is an intermediate? Is it not extremely important that we limit the number of steps in the process through which a compound can be carried and still call it an intermediate? We must stop at a certain number of steps. If carried beyond those steps it should be called a dyestuff, and placed on the same basis as a dyestuff, otherwise the tariff law will lose its effect, and we will have competition which is almost as great as it was before."

Opposing Interests.

E. S. Alton, of the Edgertyn Aniline Corporation, New York, declared that one of the biggest questions confronting the organization was the consumers of color before the war who used all their influence and brought all their influence to bear in Congress to prevent a tariff being placed on dyestuffs and intermediates. "And I think," he said, "that the American Cotton Association used every interest possible to prevent a tariff being put on dyestuffs before the war. Whether these interests are willing to co-operate with manufacturers of dyestuffs in placing a tariff on dyestuffs is a question which should be discussed between this association and the American Cotton Manufacturers' Association and the Woolen Manufacturers' Association. We should appoint a committee and get aid in placing the tariff high enough. They represent a power which we have got to get working with us before we can get the tariff placed on dyestuffs and intermediate products."

Opposition Dwindling, Says Dr. Herty.

Dr. Charles H. Herty, editor of the Journal of Industrial and Engineering Chemistry, said: "I had a conversation a few days ago in North Carolina that interested me very much as showing the change of opinion among a certain crowd. They had not been very much in sympathy with our efforts. We all must remember that one reason why we got this tariff bill was the hearty co-operation of nearly all of the consumers with the producers of dyestuffs. We have good reason to feel that the consumers of textiles have come across very squarely since this movement started. But there was a certain crowd in the country, typified by certain manufacturers in North Carolina, who were largely responsible for certain exceptions in the bill. Talking with a large mill owner, he brought up the subject of the dyestuff industry to me and remarked that 'I understand that we are going to give the dye people a fairer showing than they have had in the past. We mill men realize that we must depend on the American manufacturer and since we have had a revelation of the German methods, in peace and war, I have made up my mind that I do not want any more German dyes. We are going to see that the American manufacturers are our right-hand aids in all our work.'

"I think the American chemists should get out their pencils and find some way to shoot holes into the present tariff law, about bringing in finished dyestuffs in the form of intermediates, and take it up with the Tariff Commission."

Have Variation in Our Favor.

This evoked an enthusiastic outburst of approval as the assembled manufacturers grasped the full significance of the mill owner's change of view.

Continuing his remarks, Dr. Herty took up the question of wiping out the incongruities in our tariff laws and putting intermediates on the same basis with dyestuffs. "The object is," he said, "to build up the American dyestuff industry. The essential thing is the building up of the domestic manufacture of intermediates. It is more difficult to make certain intermediates than it is to make certain finished dyes. The law, as it stands now, gives a higher tariff on an easier made product than it gives on a more difficultly made product. Suppose the thing were shifted around the other way. That would undoubtedly result in a higher tariff on easier made products than on intermediates. The variations are against us. Why not have the variations in our favor, and then we can get at the root of all these complicated questions?"

30% Duty Too Low, Thinks Mr. Alton.

That the Germans would still be able to sell dyes here at a profit in spite of the present tariff law, was the opinion of Mr. Alton, who held that "German labor is so cheap and German raw materials procured so cheaply that they will try to come back into the countries in which they have formerly had their biggest returns.

"A duty of 30% seems small to them," he continued; "50% is also small, because they sold at such low prices, and American manufacturers will not be able to compete even with 50% duty. Vat colors is one of the greatest industries in Germany. We have no vat colors to offer except in small quantities, so they are still as strong on these colors as ever. If they do nothing else but send in vat colors, the big cotton manufacturers will drop back to them because that is the only fast cotton dye. If you reduce the tariff we will not advance any longer in vat colors. We will remain manufacturing what we are making today and cease to go any further."

More discussion followed, resulting in the decision to appoint a committee to make specific recommendations to the Tariff Commission through Dr. Jones.

Organization Committee Holds Power.

Dr. Matthews then returned to the platform to present the report of the organization committee, which asked that the committee be continued in power until the first annual meeting of the association, to be held, it was suggested, on Wednesday, March 6, in the same building. The resolution, which was passed unanimously follows:

Resolved: that the Organization Committee appointed by the chairman be empowered to continue to act as such until the first annual meeting of the association with power to

1—Prepare and file a certificate of incorporation;

2—Prepare by-laws for submission at the annual meeting;

3—Arrange the time and place of the annual meeting;

4—Entertain and pass upon applications for membership;

5—Confer with the Tariff Commission and report at the annual meeting.

And be it further resolved: that the temporary chairman, secretary and treasurer elected by this convention continue to act as such until the annual meeting.

The organization committee further suggests as a matter to be considered by the convention, the name of "Dyestuffs Association of America" as the name of this association.

The convention then adjourned to meet again March 6, at 10:30 o'clock.

FIRMS AND REPRESENTATIVES.

A Partial "Who's Who" of the Convention.

The Chemical Engineer regrets greatly that there was no official attempt made to take a complete record of those who attended the first meeting of the dyestuff industry in this country. The following list, which, however, is not complete (though not through any fault of its compiler) was prepared for Mr. McKerrow by Treasurer Charles Jenkinson:

The Sherwin-Williams Co., New York; *J. O. Hasson, manager; W. S. Woodrow, eastern manager.*

The Meth-O-Lene Co., Inc., 81 Fulton street, New York; (Tatamu, Pa.) *Frank S. Bache.*

The L. B. Fortner Co., 36 Strawberry street, Philadelphia, Pa.; *Louis B. Fortner.*

Dana & Co., Inc., 111 Broadway, New York; *E. C. Hull.*

Bowring & Co., 17 Battery place, New York: *Frank E. Morgan, chemical department.*

Dye Products & Chemical Co., Inc., 200 Fifth avenue, New York; *Clarence K. Simon, president; Morris Simon.*

John D. Lewis, Providence, R. I., *Mr. Stephen.*

Calco Chemical Co., 141 Milk street, Boston, Mass.: *J. H. Crockroft, Boston representative; F. Miller Fargo, Jr., sales manager, Woolworth building,* New York.

New York Commercial Co., 20 Vesey street, New York; *E. G. Erikson.*

The Barrett Co., 17 Battery place, New York; *Herbert G. Sidebottom, technical service manager; D. W. Jayne, manager chemical department.*

Dicks, David Co., Inc., 302 Broadway, New York; *Frank Hartley (146 Summer street, Boston, Mass.) and Albert David.*

U. S. Conditioning & Testing Co., 340 Hudson street, New York; *Edw. W. Pierce.*

E. Puigdengolas, S. C., 299 Broadway, New York: *Luis Guillo, representative. Also Barcelona, Spain.*

Chas. A. Johnson & Co., 55 Franklin street, New York; *James F. Hurley*

Geo. H. Morrill Co., Norwood, Mass.; *O. L. Peabody; Olney P. Anthony, chief chemical staff.*

Read, Holliday & Sons, Ltd., Boston, Mass., and 160 Franklin street, New York; *controlled by British Dyes, Ltd., London Norman W. Teale, secretary-treasurer; James Turner, vice-president.*

Holland Aniline Co., Holland, Michigan; *J. F. Quinlan; B. P. Donnelly.*

Stubner Chemical Works, 833 Magnolia avenue, Elizabeth, N. J.; *A. P. Sachs, chief chemist.*

Althouse Chemical Co., Reading, Pa.; *C. Scott Althouse.*

American Dyewood Co., Hoboken, N. J.; *Percival Thomas, Jr.*

John J. White, New Brunswick, N. J.

United Oil & Chemical Corp., 61 Broadway, New York; *Randolph N. Shreve, works, manager, and Mr. Ruhm and Mr. Chas. S. Wehrly.*

Buffalo Foundry & Machine Co., 17 Battery place, New York; *H. D. Case; E. G. Sleeper.*

Bureau of Standards, Washington, D. C.; *Irwin G. Priest.*

Bureau of Foreign and Domestic Commerce, Washington, D. C.: *Department of Commerce; L. F. Schmeckebier.*

Fuerst Bros. & Co., 2-4 Stone street, New York; *Samuel Levinson.*

Newport Chemical Works, Inc., Milwaukee, Wis.; *Stanley Schultz, L. I. Holdredge.*

Certified Chemical Corporation, 246 Plymouth street, Brooklyn, N. Y.; *H. O. Britton, treasurer.*

The Heller & Merz Co., Newark, N. J.; *August Merz.*

Fisher Chemical Co., dealer; *Carl Spencer Fuller, salesman.*

U. S. Tariff Commission, Washington, D. C.; *Dr. Grinnell Jones, chemist.*

Metal Disintergrating Co., 3 South William street, New York; *S. G. Schatzberg.*

John I. Solomon, *accompanying Benjamin H. Kaye.*

Fred Wetzel & Co., Clifton, N. J.; *C. Tolpfer.*

Dye Exchange Corporation, 141 Broadway, New York; *Bradford Webster.*

Peerless Color Co., Inc., Bound Brook, N. J.; *R. W. Cornelison, Sc.D.; president and general manager.*

W. H. Fieldhouse, 176 Federal street, Boston, Mass.

Essex Aniline Works, Inc., Boston, Mass., *H. W. Hyde, president.*

American Color Manufacturing Co., Passaic, N. J.; *Elvin H. Killheffer, president and treasurer.*

Berlin Aniline Works, 213 Water street, New York; *E. O. Patz, president and manager.*

Holliday-Kemp Co., Inc., 90 William street, New York; *Hugh J. McGrane, vice-president; Cornelius Tuynman, director.*

Logwood Products Corporation, 116 Broadway, New York; *S. C. de la Garza.*

Journal of Commerce, 32 Broadway, New York; *Harold S. Johnson.*

The Bayer Co., Inc., 117 Hudson street, New York; *Dr. Robert J. Pabst, Rensselaer, N. Y.; Herman C. A. Seebohm, treasurer.*

Sizing Specialty Co., 26 Florence street, Jersey City; *Alfred Spice.*

Dow Chemical Co., Midland, Mich.; *James T. Pardee, vice-president and secretary,* 1020 *Clifton boulevard, Cleveland, Ohio.*

Edward S. Chapin, consulting chemist, 516 Atlantic avenue, Boston, Mass.

U. S. Dye Extracts Co., Inc., 801 Vernon avenue, Long Island City, N. Y.

Western Aniline Products Co., Inc., Hammond; *T. C. McCall, president.*

Delta Chemical Co., 258 Broadway, New York; *J. F. Hollywood*

Edward F. Rice & Co., 620 Atlantic avenue, Boston, Mass.

R. M. & F. Waldo, 11 Broadway, New York; *Edward M. Waldo.*

Ault & Wiborg Co., Cincinnati, O.; *A. Brooking Davis, chemical director; E. A. Ault.*

Cosmic Aniline Works, Inc., 8 West Broadway, New York; *Carl Katzenstein.*

Takamine Laboratory, Inc., Equitable building, New York; *Ralph L. Reynolds.*

Manhattan Trading Corp., 2 Rector street, New York; *E. R. J. Graf, president and treasurer.*

Dunker & Perkins, 287 Atlantic avenue, Boston, Mass.; *Chas. H. Dunker, E. C. Perkins.*

Stanley Aniline Chemical Works, Lockhaven, Pa.; *Dr. I. V. Stanley Stanislaus, president.*

Cambridge Chemical & Color Co., Boston, Mass.; *W. J. Beatie.*

Middlesex Aniline Co., Inc., 732 Singer building, New York; Lincoln, N. J.; *A. R. Curtin, secretary; A. R. Kreuger, superintendent.*

Iridescent Dyestuff & Color Co., Brooklyn, N. Y.; *D. A. R. Frintz.*

New York Color & Chemical Co., Inc., 212 Pearl street, New York; *P. R. Mackinney.*

American Dyewood Co., 648 The Bourse, Philadelphia, Pa.; *P. G. Leonhardt.*

Sherman & Mason, 211 North Front street, Philadelphia, Pa.; *L. H. Mason.*

Color Investigation Laboratory, Bureau of Chemistry, Washington, D. C.; *Miss Alida M. Doyle.*

John J. White, Inc., 149 Broadway, New York; *John J. White, president.*

Frank L. May & Co., Inc., 99 John street, New York; *Arthur C. Kaufman.*

Ernest Zobel Co., Inc., Second avenue and Tenth street, Brooklyn, N. Y.; Zobel Color Works, Inc., Second avenue and Tenth street, Brooklyn, New York; Zobel, Stein & Campbell, 138 Water street, New York City; Atlas Color Works, Colours Co., Inc., *all represented by Wyckoff Bennett.*

Graselli Chemical Co., 80 Maiden Lane, New York.

Marden, Orth & Hastings Co., 61 Broadway, New York; *Shepherd M. Crain, Jr., assistant manager; C. A. Mace, sales manager, and Herman G. Weicker.*

Bay State Chemical Co., Boston, Mass.; *E. J. Feeley.*

Dicks, David & Co., 302 Broadway, New York; *Benj. F. Lippold.*

Stillman & Van Sielen Chemical Laboratory Co., Inc., 6 Church and 109 Liberty streets, New York.

John C. Sparks, 30 Church street, New York.

T. S. Todd & Co., 42 Broadway, New York.

Edgertyn Aniline Corp., 118 William street, New York; *E. S. Alton.*

Jennings & Co., 261 Franklin street, Boston, Mass.; *Waldo Farrar.*

Nathan Salowejizyk, 976 Anderson avenue, New York; *N. Solow*

Hine Bros., 80 Maiden Lane, New York; *Arthur Hine.*

Canadian Electro Products Co., Ltd., Montreal, Canada; *Victor G. Bartram.*

Watson, Jack & Co., Ltd., Power building, Montreal, Canada; *W. R. Allen.*

F. X. M. Lehmann, 261 Broadway, New York.

J. D. Lewis, Providence, R. I.; *J. P. Stephan.*

Ellwood Hendrick, 139 East Fortieth street, New York.

Western Reserve Chemical Co., 3434 East Ninety-third street, Cleveland, O.; *H. J. Sherwood.*

Frank Hemingway, Inc., 115 Broadway, New York; *Frank Hemingway.*

(Concluded on page 120)

INORGANIC CHEMICAL SYNONYMS

A Novel Work of Reference for Student and Chemist

By Elton R. Darling[*]

Although Intended Primarily for the Student, It Is Believed That the Following Compilation of the Various Terms Employed to Designate Inorganic Chemicals Used in the Industries, Will Prove a Convenience to the Experienced Chemist. The Writer Claims No Originality for the Synonyms, but Only the Bibliographical Research of the Material at Hand. Part II Will Appear in the Next Issue.

PART I.

This article is the result of the writer's experiences in the laboratory and his dealings with young chemists from the universities. It has been prepared in the hope that it will fill a need which has repeatedly manifested itself in the struggles of students to grasp quickly the laboratory significance of many chemical terms often met with in the persual of the average popular "trade" treatise describing this or that process of industrial chemistry.

"Chemical Colloquialisms."

It is a matter of common knowledge that some of the chemicals used in commercial work are known by as many as twenty varying terms or synonyms. It is also true that a single chemical may be known by terms which differ slightly or greatly according to the geographical location in which it chances to be in use. In short, colloquialisms spring up in the language of chemistry quite as readily as they do in any language, and such variations in nomenclature are often confusing to student and chemist alike. This is particularly true when the unhappy individual suddenly finds himself obliged to "read up"—in a hurry, perhaps—on some subject with which he is not thoroughly familiar.

Even in technical works devoted to the chemical industries, two writers will frequently employ different terms to designate the same chemical compound. The result is sometimes guesswork and ultimate abandonment of the treatise for another; at the very least it means annoying delay, accompanied by the fervent wish that one had a ready means of ascertaining whether "Alum Flour," "Potash Alum," and "Octahedral Alum Salt" all mean our laboratory friend Aluminum Potassium Sulfate, or three entirely different compounds of aluminum.

The writer himself has frequently felt this need and knows it to exist. It is, indeed, surprising what a large percentage of students are familiar only with the true chemical terms and quite in the dark as to their synonyms. It would seem fitting that the latter part of the courses in inorganic chemistry should devote some time to this subject. In the absence of this, the following list of some of the more common chemicals and their synonyms has been prepared. The writer claims no originality for the synonyms, but only the bibliographical research of the material at hand.

While this work is intended primarily for the student, it is believed that the practical chemist will profit by it.

Fundamentals.

For the reason that no work of reference would be quite complete without the inclusion of such fundamental matter as tables of the elements, atomic weights, specific gravity, etc., together with comparisons of the various systems of weight, capacity, volume and temperature measurement, the preface to the present compilation will be further expanded by the presence of these facts and figures.

THE ELEMENTS.

All of the elements at ordinary temperature are not in the solid state. Two are liquids and ten are gases. The liquid elements are bromine and mercury. The gaseous elements are oxygen, hydrogen, chlorine, fluorine, nitrogen, argon, helium, krypton, neon, and xenon.

The solid or metallic elements have at varying temperatures been liquified with the exception of carbon. This element can only be softened when subjected to the highest known temperature.

The table of atomic weights was compiled by the International Committee on Atomic Weights consisting of F. W. Clarke, W. Ostwald, T. E. Thorpe, and G. Urbain.

Their Symbols and Atomic Weights.

Aluminum	Al	27.1
Antimony	Sb	120.2
Argon	A	39.88
Arsenic	As	74.96
Barium	Ba	137.37
Bismuth	Bi	208.0
Boron	B	11.0
Bromine	Br	79.92
Cadmium	Cd	112.40
Caesium	Cs	132.81
Calcium	Ca	40.07
Carbon	C	12.00
Cerium	Ce	140.25
Chlorine	Cl	35.46
Chromium	Cr	52.
Cobalt	Co	58.97
Columbium	Cb	93.5
Copper	Cu	63.57
Dysprosium	Dy	162.5
Erbium	Er	167.7

---

[*] All rights of publication in book form reserved by the author. Research Textile Chemist, 251 Clifton Place, Brooklyn, N. Y.

Europium	Eu	152.0
Fluorine	F	19.0
Gadolinium	Gd	157.3
Gallium	Ga	69.9
Germanium	Ge	72.5
Glucinum	Gl	9.1
Gold	Au	197.2
Helium	He	3.99
Holmium	Ho	163.5
Hydrogen	H	1.008
Indium	In	114.8
Iodine	I	126.92
Iridium	Ir	193.1
Iron	Fe	55.84
Krypton	Kr	82.92
Lanthanum	La	139.
Lead	Pb	207.10
Lithium	Li	6.94
Lutecium	Lu	174.0
Magnesium	Mg	24.42
Manganese	Mn	54.93
Mercury	Hg	200.6
Molybdenum	Mo	96.0
Neodymium	Nd	144.3
Neon	Ne	20.2
Nickel	Ni	58.68
Niton	Nt	222.4
Nitrogen	N	14.01
Osmium	Os	190.9
Oxygen	O	16.00
Palladium	Pd	106.7
Phosforus	P	31.04
Platinum	Pt	195.2
Potassium	K	39.10
Praseodymium	Pr	140.6
Radium	Ra	226.4
Rhodium	Rh	102.9
Rubidium	Rb	85.45
Ruthenium	Ru	101.7
Samarium	Sa	150.4
Scandium	Sc	44.1
Selenium	Se	79.2
Silicon	Si	28.3
Silver	Ag	107.88
Sodium	Na	23.0
Strontium	Sr	87.63
Sulfur	S	32.07
Tantalum	Ta	181.5
Tellurium	Te	127.5
Terbium	Tb	159.2
Thallium	Tl	204.0
Thorium	Th	232.4
Thulium	Tm	168.5
Tin	Sn	119.
Titanium	Ti	48.1
Tungsten	W	184.
Uranium	U	238.5
Vanadium	V	51.
Xenon	Xe	130.2
Ytterbium or Neoytterbium	Yb	172.0
Yttrium	Yt	89.
Zinc	Zn	65.37
Zirconium	Zr	90.6

Their Discoverers and Dates of Discovery.

In the following list Helium will be found twice; the first date, 1868, refers to its discovery in the sun by Lockyer. It was again discovered in 1895 by Ramsay, who found it among the elements of the earth.

Although Uranium was discovered in the early part of 1780 its radio-active properties were not known until 1896.

	Mercury	This was known to the ancients
	Gold	This was known to the ancients
	Silver	This was known to the ancients
	Iron	This was known to the ancients
	Copper	This was known to the ancients
	Lead	This was known to the ancients
	Carbon	This was known to the ancients
1450	Antimony	Valentine (Ger. Alchemist)
1450	Bismuth	Valentine (Ger. Alchemist)
1520	Zinc	Paracelsus (Swiss Chemist)
1694	Arsenic	Schroder (German)
1733	Cobalt	Brandt (German)
1738	Phosphorus	Brandt (German)
1741	Platinum	Wood (English)
1751	Nickel	Cronstadt (Russian)
1766	Hydrogen	Cavendish (English)
1772	Nitrogen	Rutherford (English)
1774	Manganese	Gahn (Swedish)
1774	Oxygen	Priestley (English)
1780	Uranium	Klaproth (German)
1781	Tungsten	d'Elihujar (Spanish)
1782	Molybdenum	Hjilm (Swedish)
1782	Tellurium	Reichinstun (German)
1795	Titanium	Klaproth (German)
1797	Chromium	Vauguelin (French)
1801	Tantalum	Hatchett (English)
1801	Cerium	Berzelius and Hizinger (Swedish)
1801	Vanadium	Del Rio (Spanish)
1803	Osmium	Tennant (English)
1803	Palladium	Wollaston (English)
1804	Iridium	Tennant (English)
1804	Rhodium	Davy (English)
1807	Potassium	Davy (English)
1807	Sodium	Davy (English)
1808	Barium	Davy (English) and Berzelius (Swedish)
1808	Strontium	Davy (English)
1808	Boron	Davy (English) and Gay-Lussac (French)
1808	Magnesium	Davy (English)
1808	Calcium	Davy (English) and Berzelius (Swedish)
1810	Chlorine	Davy (English)
1810	Fluorine	Ampere (French)
1811	Iodine	Courtois (French)
1817	Selenium	Berzelius (Swedish)
1817	Lithium	Arfvedson (Swedish)
1817	Cadmium	Herman and Strohmeyer (German)
1823	Silicon	Berzelius (Swedish)
1824	Zirconium	Berzelius (Swedish)
1826	Bromine	Balard (French)
1827	Beryllium	Wohler (German)
1827	Aluminum	Wohler (German)
1828	Thorium	Berzelius (Swedish)
1828	Yttrium	Wohler (German)
1841	Lanthanum	Mosander (Swedish)
1843	Terbium	Mosander (Swedish)
1843	Erbium	Mosander (Swedish)
1844	Ruthinium	Claus (German)
1846	Columbium	Rose (English)
1860	Caesium	Bunsen and Kirchloff (German)
1862	Thallium	Crooks (English)
1863	Indium	Reich and Richer (German)
1868	Helium	Lockyer (English)
1868	Rubidium	Bunsen (German)
1875	Gallium	Boisbaudran (French)
1878	Ytterbium	Marignac (French)
1879	Thulium	Cleve (Swedish)

1879	Scandium	Nilson (Swedish)
1879	Samarium	Boisbaudran (French)
1885	Praseodymium	Welsbach (German)
1885	Neodymium	Welsbach (German)
1886	Gadolinium	Marignac (French)
1886	Germanium	Winkler (German)
1894	Argon	Rayleigh and Ramsay (English)
1895	Helium	Ramsay (English)
1897	Krypton	Ramsay and Travers (English)
1898	Xenon	Ramsay (English)
1898	Neon	Ramsay and Travers (English)
1898	Radium	Curie (French)

Occurrence of the Metals in Nature.

Aluminum as the silicate.
Antimony as the sulfide.
Arsenic as the sulfide.
Barium as the sulfate.
Bismuth as the oxide, sulfide. Also metallic.
Cadmium as the oxide, carbonate, and sulfide.
Calcium as the carbonate, sulfate and silicate.
Chromium as the oxide.
Cobalt as the sulfide.
Copper as the sulfide, oxide and carbonate.
Iron as the oxide, sulfide and carbonate.
Lead as the sulfide.
Magnesium as the carbonate, sulfate, and silicate.
Manganese as the oxide.
Mercury as the metal or sulfide.
Nickel as the sulfide.
Silver as the metal or sulfide.
Sodium as the chloride and silicate.
Strontium as the carbonate, sulfate, and silicate.
Tin as the oxide.
Zinc as the oxide, carbonate, and sulfide.

SPECIFIC GRAVITY AND TEMPERATURE COMPARISONS.

Fahrenheit—Centigrade—Reaumur.

Fahrenheit	Centigrade	Reaumur
+212	+100	+80
210.2	99	79.2
208.4	98	78.4
206.6	97	77.6
204.8	96	76.8
203.	95	76.
201.2	94	75.2
199.4	93	74.4
197.6	92	73.6
195.8	91	72.8
194.	90	72.
192.2	89	71.2
190.4	88	70.4
188.6	87	69.6
186.8	86	68.8
185.	85	66.
183.2	84	67.2
181.4	83	66.4
175.6	82	65.6
177.8	81	64.8
176.	80	64.
174.2	79	63.2
172.4	78	62.4
170.6	77	61.6
168.8	76	60.8
167.	75	60.
165.2	74	59.2
163.4	73	58.4
161.6	72	57.6
159.8	71	56.8
158.	70	56.
156.2	69	55.2
154.4	68	54.4
152.6	67	53.6
150.8	66	52.8
149.	65	52.
147.2	64	51.2
145.4	63	50.4
143.6	62	49.6
141.8	61	48.8
140.	60	48.
138.2	59	47.2
136.4	58	46.4
134.6	57	45.6
132.8	56	44.8
131.	55	44.
129.2	54	43.2
127.4	53	42.4
125.6	52	41.6
123.8	51	40.8
122.	50	40.
120.2	49	39.2
118.4	48	38.4
116.6	47	37.6
114.8	46	36.8
113.	45	36.
111.2	44	35.2
109.4	43	34.4
107.6	42	33.6
105.8	41	32.8
104.	40	32.
102.2	39	31.2
100.4	38	30.4
98.6	37	29.6
96.8	36	28.8
95.	35	28.
93.2	34	27.2
91.4	33	26.4
89.6	32	25.6
87.8	31	24.8
86.	30	24.
84.2	29	23.2
82.4	28	22.4
80.6	27	21.6
78.8	26	20.8
77.	25	20.
75.2	24	19.2
73.4	23	18.4
71.6	22	17.6
69.8	21	16.8
68.	20	16.
66.2	19	15.2
64.4	18	14.4
62.6	17	13.6
60.8	16	12.8
59.	15	12.
57.2	14	11.2
55.4	13	10.4
53.6	12	9.6
51.8	11	8.8
50.	10	8.
48.2	9	7.2
46.4	8	6.4
44.6	7	5.6
42.8	6	4.8
41.	5	4.
39.2	4	3.2
37.4	3	2.4
35.6	2	1.6
33.8	1	0.8
32.	0	0.

Comparison of Specific Gravity with Degrees, Twaddle and Beaume.

Sp. Gr. at 15° C.	Degrees Be'	Degrees Tw.
1.000	0.0	0
1.005	0.7	1
1.010	1.4	2
1.015	2.1	3
1.020	2.7	4
1.025	3.4	5
1.030	4.1	6
1.035	4.7	7
1.040	5.4	8
1.045	6.0	9
1.050	6.7	10
1.055	7.4	11
1.060	8.0	12
1.065	8.7	13
1.070	9.4	14
1.075	10.0	15
1.080	10.6	16
1.085	11.2	17
1.090	11.9	18
1.095	12.4	19
1.100	13.	20
1.105	13.6	21
1.110	14.2	22
1.115	14.9	23
1.120	15.4	24
1.125	16.	25
1.130	16.5	26
1.135	17.1	27
1.140	17.7	28
1.145	18.3	29
1.150	18.8	30
1.155	19.3	31
1.160	19.8	32
1.165	20.3	33
1.170	20.9	34
1.175	21.4	35
1.180	22.	36
1.185	22.5	37
1.190	23.	38
1.195	23.5	39
1.200	24.	40
1.205	24.5	41
1.210	25.	42
1.215	25.5	43
1.220	26.	44
1.225	26.4	45
1.230	26.9	46
1.235	27.4	47
1.240	27.9	48
1.245	28.4	49
1.250	28.8	50
1.255	29.3	51
1.260	29.7	52
1.265	30.2	53
1.270	30.6	54
1.275	31.1	55
1.280	31.5	56
1.285	32.	57
1.290	32.4	58
1.295	32.8	59
1.300	33.3	60
1.305	33.7	61
1.310	34.2	62
1.315	34.6	63
1.320	35.	64
1.325	35.4	65
1.330	35.8	66
1.335	36.2	67
1.340	36.6	68
1.345	37.	69
1.350	37.4	70
1.355	37.8	71
1.360	38.2	72
1.365	38.6	73
1.370	39.	74
1.375	39.4	75
1.380	39.8	76
1.385	40.1	77
1.390	40.5	78
1.395	40.8	79
1.400	41.2	80
1.405	41.6	81
1.410	42.	82
1.415	42.3	83
1.420	42.7	84
1.425	43.1	85
1.430	43.4	86
1.435	43.8	87
1.440	44.1	88
1.445	44.4	89
1.450	44.8	90
1.455	45.1	91
1.460	45.4	92
1.465	45.8	93
1.470	46.1	94
1.475	46.4	95
1.480	46.8	96
1.485	47.1	97
1.490	47.4	98
1.495	47.8	99
1.500	48.1	100
1.505	48.4	101
1.510	48.7	102
1.515	49.	103
1.520	49.4	104
1.525	49.7	105
1.530	50.	106

Comparison of Specific Gravity and Degrees, Beaume.

For Liquids Heavier than Water

Degrees Be'	Spec. Gravity at 12° C.
0	1.40
1	1.0069
2	1.0140
3	1.0212
4	1.0285
5	1.0358
6	1.0434
7	1.0509
8	1.0587
9	1.0665
10	1.0745
11	1.0825
12	1.0907
13	1.0990
14	1.1074
15	1.1160
16	1.1247
17	1.1335
18	1.1425
19	1.1516
20	1.1608
21	1.1702
22	1.1798
23	1.1896
24	1.1994

Degrees Be'	Spec. Gravity at 12° C.
25	1.2095
26	1.2198
27	1.2301
28	1.2407
29	1.2515
30	1.2624
31	1.2736
32	1.2849
33	1.2965
34	1.3082
35	1.3202
36	1.3324
37	1.3447
38	1.3574
39	1.3703
40	1.3834
41	1.3968
42	1.4105
43	1.4244
44	1.4386
45	1.4531
46	1.4678
47	1.4828
48	1.4984
49	1.5141
50	1.5301
51	1.5466
52	1.5633
53	1.5804
55	1.5987
55	1.6158
56	1.6342
57	1.6529
58	1.6720
59	1.6916
60	1.7116
61	1.7322
62	1.7532
63	1.7748
64	1.7960
65	1.8195
66	1.8428
67	1.8590
68	1.8640
69	1.8850
70	1.9090
71	1.9350
72	1.9600

For Liquids Lighter than Water

Degrees Be'	Spec. Gravity at 12° C.
10	1.0000
11	0.9932
12	0.9865
13	0.9799
14	0.9733
15	0.9669
16	0.9605
17	0.9542
18	0.9480
19	0.9420
20	0.9359
21	0.9300
22	0.9241
23	0.9183
24	0.9125
25	0.9068
26	0.9012
27	0.8957
28	0.8902
29	0.8848
30	0.8795
31	0.8742
32	0.8690
33	08639
34	0.8588
35	0.8538
36	0.8488
37	0.8439
38	0.8391
39	0.8343
40	0.8295
41	0.8249
42	0.8202
43	0.8156
44	0.8111
45	0.8066
46	0.8022
47	0.7978
48	0.7935
49	0.7892
50	0.7849
51	0.7807
52	0.7766
53	0.7725
54	0.7684
55	0.7644
56	0.7604
57	0.7565
58	0.7526
59	0.7487
60	0.7449

STANDARDS OF WEIGHTS AND MEASURES.

By a mutual action taken by the governments of the world the International Bureau of Weights and Measures was established near Paris on the 20th of May, 1875. The standards were made of platinum-iridium in a ratio of nine parts of the former to one part of the latter. The originals are kept in the archives of the Bureau of Standards in Paris.

Duplicate standards have been sent to the various governments who are members of the bureau.

The standard of length is the meter and is a duplicate of the International Standard Meter. It was originally defined as the forty-millionth part of the quadrant of the meridan at Paris, and is the distance between two points at 0° C. on the original standard platinum-iridium bar.

The kilogram is the weight of a cylinder of the same alloy at 0° C. made in vacuo.

The litre is equal to a cubic decimeter. This is determined by measuring this quantity of distilled water at 4° C., which is the temperature of its greatest density. All weighings are made in vacuo.

As the metric system is the standard used by the chemist, such tables will be given. But for the student, comparisons with the other systems will be given, as the metric system is not being universally taught as yet.

Weight.

Metric System.

Milligram	Equals	.001	Gram
Centigram	Equals	.01	Gram
Decigram	Equals	0.1	Gram

Gram	Equals	1000 Grams
Dekagram	Equals	10 Grams
Hectogram	Equals	100 Grams
Kilogram	Equals	1000 Grams
Myriangram	Equals	10 Kilograms
Quintal	Equals	100 Kilograms
Millier	Equals	1000 Kilograms or 1 Ton

Metric to Avoirdupois

Milligram	Equals	0.01543 Grains
Centigram	Equals	0.1543 Grains
Decigram	Equals	1 1.543 Grains
Gram	Equals	15.43 Grains
Dekagram	Equals	5.6438 Drams
Hectogram	Equals	3,527 Ounces
Kilogram	Equals	2.2046 Pounds
Myriangram	Equals	22.046 Pounds
Quintal	Equals	1.9684 CWT.
Millier	Equals	1.1023 Short Ton

Avoirdupois to Metric

Grain	Equals	0.0648 Gram
Dram	Equals	1.772 Gram
Ounce	Equals	28.35 Grams
Pound	Equals	.4536 Kilograms
Hundredweight	Equals	45.36 Kilograms
Ton	Equals	.9071 Millier

Metric to Troy

Milligram	Equals	.00487 Carats
Centigram	Equals	.0487 Carats
Decigram	Equals	4.87 Carats or 1.5432 Grains
Gram	Equals	487 Carats or 1.5432 Grains
Dekagram	Equals	6.43 Pennyweight
Hectogram	Equals	3.215 Ounces
Kilogram	Equals	2.679 Pounds

Troy to Metric

Grain	Equals	.0648 Gram
Pennyweight	Equals	1.5552 Grams
Ounce	Equals	31.103 Grams
Pound	Equals	.3732 Kilogram

Metric to Apothecary

Milligram	Equals	.0154 Grains
Centigram	Equals	.154 Grains
Decigram	Equals	1.54 Grains
Gram	Equals	.7716 Scruple
Dekagram	Equals	2.572 Drams
Hectogram	Equals	3.215 Ounces
Kilogram	Equals	2.679 Pounds

Apothecary to Metric

Grain	Equals	.0648 Grams
Scruple	Equals	1.3 Grams
Dram	Equals	3.888 Grams
Ounce	Equals	31.103 Grams
Pound	Equals	.3732 Kilogram

Capacity.

Metric System

Milliliter	Equals	16.2 Minims
Centiliter	Equals	.238 Fluid Ounces
Decileter	Equals	.845 Gill
Liter	Equals	1.0567 Quarts
Decaliter	Equals	2.6417 Gallons
Hectoliter	Equals	264.17 Gallons
Kiloliter	Equals	264.17 Gallons

U. S. equivalent to Metric

Gill	Equals	118.29 C. C.
Pint	Equals	0.4732 Liter
Quart	Equals	0.9464 Liter
Gallon	Equals	3.7854 Liter

Apothecaries' Liquid Capacity to Metric

Minim	Equals	.0616 C. C.
Fluid Gram	Equals	3.7 C. C.
Fluid Ounce	Equals	29.57 C. C.
Pint	Equals	.4732 Liter
Quart	Equals	0.9464 Liters
Gallon	Equals	7854 Liters

Volume.

Metric System

Milliliter	Equals	.06102 Cu. In.
Centiliter	Equals	.6102 Cu. In.
Deciliter	Equals	6.102 Cu. In.
Liter	Equals	61.02 Cu. In.
Decaliter	Equals	610.2 Cu. In
Hectoliter	Equals	3.5314 Cu. Ft.
Kiloliter	Equals	1.308 Cu. Yd.

U. S. equivalent to Metric

Cubic Inch	Equals	16.387 C. C.
Cubic Foot	Equals	28.32 Liters
Cubic Yard	Equals	764.5 Liters

CHEMICAL SYNONYMS.

Aluminum 27.5.

Specific gravity 2.7, fuses at 450°C.; melting point 657°C.; has a boiling point above 2200°C. It is trivalent but is also looked upon (when expressed as the double atoms) as a single sexivalent atom.

The name aluminum is derived from the Latin word alumen. Alumen was a term used by the Romans in reference to bodies possessing an astringent taste.

The first mention made to alum was that of Pott, who in 1746 stated that the basis of it was clayey material. In 1754 Marggraf confirmed Pott's views, but added that there was a difference between alumina and lime.

Davy in 1807 and Oersted in 1824 tried to purify the metal, but were unsuccessful. In 1827 Wohler repeated the work of Oersted, and not having success, turned to the decomposition of the chloride with potassium and thus was the first to obtain the metal in its pure state.

Aluminum Acetate 204.17.
- *Alumini Acetas*
- *Aluminic Acetate*
- *Mordant Salts*
- *Waterproofing Salts*
- *Printer's Acetate*
- *Red Liquor*
- *Oil Pulp*
- *Fluid Gelatine*

Aluminum Chloride 266.96
- *Alumini Chloridum*
- *Aluminic Chloride*
- *Chloralum*
- *Muriate of Alumina*
- *Sesquichloride of Aluminum*

Aluminum Hydrate 120.22
- *Alumini Hydroxidum*
- *Aluminic Hydrate*
- *Aluminum Hydroxide*
- *Hydrated Alumina*
- *Hydrargillite (native)*
- *Gibbsite (native)*
- *Diaspori (native)*

Aluminum Oxide 122.14
- *Alumini Oxidum*
- *Aluminic Oxide*
- *Alumina*
- *Corundum*

(*Continued on page* 120)

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By Carleton Ellis and A. A. Wells.*

PART X

CHLORINATION OF PARAFFIN HYDROCARBONS.

In the production of chlorinated compounds of saturated hydrocarbons, *Blanc,* (U. S. patent 1,248,065, Nov. 27, 1917) makes use of light rays for activating the reaction. In addition to the activating effect of the light, catalyzers may also be used. An apparatus for carrying out the process is described, see Fig. 1, in which a chamber containing the hydrocarbon to be chlorinated is fitted with windows, transparent to the light waves which are employed. In the illustration, the right hand tube is for the admission of chlorine, the separatory funnel is for the addition of hydrocarbon; next to the separatory funnel is a reflux condenser and at the left is a tube for the return of material which has passed through the apparatus and is not sufficiently chlorinated. Ultra violet light may be used, the position of the lamps being indicated by the two electrical bulbs located on the sides of the chamber. The outlet tube at the lower left-hand corner is for drawing off the chlorinated material.

A method for absorbing the hydrochloric acid given off by the reaction, thus purifying the chlorine which is unabsorbed and making it suitable for return to the chamber, is described; also means for fractionating the chlorinated material and returning those portions which are not sufficiently chlorinated. It is stated by Blanc that small amounts of moisture are favorable to chlorination and for this reason the chlorine is bubbled through water before entering the reaction chamber.

CHLORINATION OF AROMATIC HYDROCARBONS.

A process for the manufacture of side chain derivatives of chlorine from toluol is proposed by *Gibbs* and *Geiger* (U. S. patent 1,246,739, Nov. 13, 1917). They note that among the various methods for the chlorination of toluol in the side chain are the following:

(1) By passing chlorine into boiling toluol in the presence of light until a certain weight of the chlorine is absorbed, a mixture of the different chlorine compounds is produced. The principal products are those in which the chlorine is substituted in the side chain, but there are also present compounds containing chlorine in the ring.

(2) On mixing gaseous toluol in excess and chlorine gas in the presence of light and a catalyst, only a portion of the toluol is attacked with the production of benzyl chloride. The latter is mixed with unattacked toluol and the catalyst and must be subjected to a purification process which adds to the expense of the process.

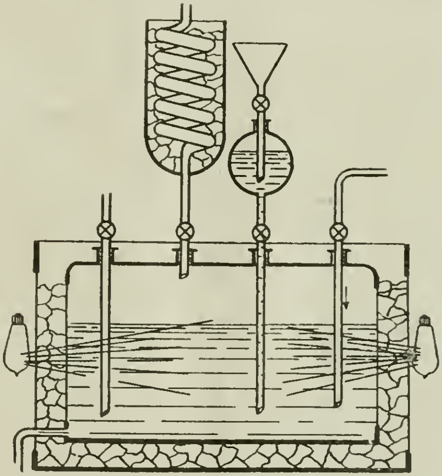


Figure 1.—Blanc's Apparatus for the Chlorination of Aliphatic Hydrocarbons.

(3) By mixing gaseous toluol with an excess of chlorine gas in the presence of a catalyst a mixture of benzyl chloride, benzal chloride, benzotrichloride, chlor-toluol, chlor-benzyl chloride, etc., is produced. The action is somewhat analogous to (1,) above mentioned, due to the fact that the reaction takes place in successive stages and yield of any one desired product cannot be exactly controlled.

Gibbs and Geiger state that when toluol in the vapor form is mixed with chlorine gas in the definite theoretical proportions to produce chlorinated side chain products and the mixture exposed to ultra violet rays, the bodies desired are produced in greatly increased yields and without the production of interfering by-products. The operation is rendered continuous by constantly feeding to the zone of light the vapors of toluol and chlorine gas and by carefully regulating the speed at which these reacting substances enter the reaction chamber a high degree of purity results. They state it is advisable to work without the presence of a catalyst, as it is not essential to the reaction and would tend to contaminate the product.

---

*All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

According to this process benzyl chloride, benzal chloride and benzotrichloride may be produced according to the proportion of chlorine employed.

Examples are the following:

The reaction chamber, consisting of material resistant to all substances taking part in or produced by the reaction, is swept clear of air by the introduction of an inert gas, such as carbon dioxide. This reaction chamber is provided with a lamp such as the quartz mercury lamp. The liquid toluol is then fed by means of a pump at the rate of 60 grams per minute into a vaporizer heated by a resistance coil which converts the toluol into the gaseous condition. The vapor is then fed from the vaporizer into the reaction chamber. The chlorine is delivered from the cylinder or electrolytic cell through a measuring apparatus directly into the reaction chamber through a tube concentric with that of the toluol tube at the rate of 46 grams per minute. The product of the reaction collects on the bottom of the chamber and is drawn off at intervals without the introduction of air. The hydrochloric acid formed is led off through the top of the chamber and absorbed in water.

For making benzal chloride or benzotrichloride the features outlined above are the same except that the rates of delivery of toluol and chlorine are different. To produce benzal chloride the toluol is delivered at a rate of 60 grams per minute and the chlorine at 92.5 grams per minute. For benzotrichloride the rates are, toluol 60 grams per minute, chlorine 139 grams per minute.

Gibbs and Geiger are employees of the Department of Agriculture and have dedicated their patent rights to the public.

PEPPERMINT OIL.

It is a well known fact that good quality peppermint oil when used as a flavoring for certain candies or sugar preparations, such as ordinary mint tablets, loses its fine flavor on long standing. In the writer's laboratory a number of samples of mint tablets were exposed to the action of ultra violet light in order to test the stability of certain mint oils in the manufacture of confections. It was found that a few hours' exposure to the light afforded approximately the same ageing effect as standing on the shelves for a period of several months. The procedure appears to be a ready method of testing materials of this class to quickly determine their keeping qualities.

VARIOUS OILS AND RESINS.

In the writer's laboratory numerous experiments have been made to test the effect of ultra violet light on various oils, resins, etc., especially in regard to the bleaching action and polymerization. A résumé of some of these tests follows. The lamp used was a Cooper-Hewitt quartz burner, using one hundred and fifty volts at three and a half amperes.

The following oils, among others, were subjected to the action of ultra violet rays to ascertain whether any bleaching effect was exerted: Crude cottonseed oil, linseed oil, crude whale oil (No. 3) and lubricating oil of medium body and strongly fluorescent. The oils were exposed in shallow pans in layers about three-sixteenths of an inch thick and spaced about eleven inches from the burner. After three hours' exposure the linseed oil had a very heavy film over the surface. The cottonseed and whale oils had slight films, while the surface of the lubricating oil was apparently unaltered. After six hours' exposure the cottonseed oil had greatly increased in viscosity, the linseed and whale oil had commenced to gelatinize and the lubricating oil had become slightly darker. At the end of thirteen and a half hours the cottonseed oil had gelatinized and was slightly bleached. The linseed oil had become a stiff jelly and the linseed odor was diminished. The color was apparently unchanged. The whale oil was considerably deodorized and slightly bleached. The lubricating oil had become somewhat darker, but the fluorescence had completely disappeared. (See Ellis, U. S. patent 1,089,359, Mar. 3, 1914.)

On exposure of whale oil in layers about three-sixteenths of an inch in thickness and placed four inches from the burner for ten hours, a dark amber-colored jelly resulted, the odor of which was very faint as compared with the original oil. Crude cottonseed oil exposed for seven hours at a distance of six inches from the burner gave a stiff amber-colored jelly. The jelly was considerably lighter than the original oil and the iodine value had fallen to 56. China wood oil treated under the same conditions gave a hard jelly which on exposure for an hour or so became so brittle that it could be easily pulverized. The powdered product was almost white. The iodine value of this product was 93. Linseed oil treated in the same manner gave a resilient translucent jelly of practically the same color as the original oil. A highly refined cottonseed oil placed four inches from the burner for thirteen hours gave an amber colored jelly of practically the same color and consistency as the crude cotton oil. Castor oil when exposed at a distance of three inches from the burner for ten and a half hours gave a product which was identical in appearance and odor to that obtained from cottonseed oil. Red oil (crude oleic acid) when exposed for fourteen hours at a distance of four inches from the burner gave an entirely different product from the other oils. It was noted that fumes were given off at a very low temperature. At 85° C. slight fuming was noticed. At 110° C. copious fumes were given off. The manner in which this oil thickens suggests crystallization, while in the case of cotton oil or castor oil the solidification resembles coagulation. In the case of red oil a thin film forms over the surface and apparently protects the under layer from further action until this film is removed. The oil when completely solidified is hard without any suggestion of tackiness. It is perfectly black and practically odorless. A highly refined edible corn oil when placed four inches from the burner for fourteen hours gave a jelly of a very light yellow color. The change of a fatty oil from a liquid to a solid state is very gradual, the oil becoming slightly viscous at first, then increasing gradually in viscosity until it finally assumes the jelly form. Immediately before the mass commences to solidify a large number of small bubbles usually appear beneath the surface of the oil and these may still be observed after the oil has become completely solid.

Comparative Rapidity of Polymerization.

It is of interest that, although the gelatinized crude cottonseed oil was considerably lighter than the original crude product, the gelatinized refined oil as prepared above was much darker than the original refined oil. The average temperature of the oil during these experiments was 110°. It was noted that crude cottonseed oil, at relatively low temperatures, fumed slightly under the action of ultra violet light, while the refined oil did not give off any fumes until the temperature had reached about 160° C. Even at that point the fuming was only slight. The conclusion which may be drawn from these experiments and from some others carried out under practically the same conditions is that crude oil polymerizes and gelatinizes more rapidly than refined oil.

The question arose as to whether this gelatinizing effect was due to oxidation or mainly to the action of the rays themselves. In order to determine this, oil was placed in a tubular quartz container and the opening carefully sealed. The tube was then exposed to the action of the ultra violet light for five hours at a distance of four inches from the burner. At the end of this time the oil had become thickened so that it would no longer flow in the tube. The experiment was then repeated. This time the tube was filled completely with oil at the temperature at which the oil was to be exposed to the ultra violet light and the open end was carefully sealed. The tube was exposed to the ultra violet light for ten hours and at the end of this period the bubbles previously mentioned had begun to appear and the oil had become highly viscous. Thus, ultra violet light in the absence of oxygen is able to thicken and polymerize some fatty oils. In the presence of oxygen, however, the results of a number of tests indicate the solidification of unsaturated fatty oils under the influence of the ultra violet light is due jointly to oxidation and polymerization.

In one case ordinary cottonseed oil was mixed with five per cent. of sulphur and exposed to the action of ultra violet light for three hours at 150° C. and remained liquid after the treatment, but an oil which had been exposed until it was practically at the gelatinization point and then had the same amount of sulphur added, on exposure to ultra violet light in the same way yielded a black rubber-like solid.

In view of the results obtained with unsaturated fatty oils, a sample of oil which had been hydrogenated to a titre of 54° C., was exposed to the ultra violet light. This oil was exposed in the same manner as the other oils, but for a period of thirty hours. At the end of this time practically no change was noted either in color, odor or viscosity. The stability of the oil under these drastic conditions was of interest.

In another case a mixture of equal parts of rosin and corn oil having the consistency of honey was exposed in a thin layer to the action of ultra violet light at a distance of four inches from the burner. After five hours the product had become extremely viscous and was somewhat darkened. A longer exposure of another sample at a distance of fourteen inches from the burner gave a product of about the same consistency, although much lighter in color. The carbonizing or discoloring effect of exposure very close to the burner was repeatedly noted. The discoloration may be due partly to the rays and partly to local superheating of the upper layers of oil.

In order to obtain an idea of how long an exposure is necessary to completely solidify the oil when exposed to the ultra violet light in a very thin film, a layer of cotton oil about one-sixteenth of an inch in thickness was exposed at a distance of four inches from the burner and the consistency noted every minute. The oil commenced to thicken almost immediately and at the end of fourteen minutes had completely solidified to a very thick jelly. To determine whether thicker layers of oil were opaque to the ultra violet rays, cottonseed oil was exposed at a distance of four inches from the burner, the depth of oil in this instance being one and one-half inches. After an exposure of seven and one-half hours it was found that the entire mass of oil had become solid and was nearly uniform throughout, the product being a dark colored jelly.

An interesting fact about some of the gelatinized products mentioned above is that on exposure to the air for about twenty-four hours they become opaque and quite brittle. If the product is tacky on removal from the burner, the surface loses its tackiness in a very short time. This drying progresses through the film until finally there forms a brittle mass which can be easily powdered.

Oxidation of Soya Bean Oil.

Experiments on the oxidation and polymerization of soya bean oil have been carried out by *Taverne* (Z. angew. Chem. 27, 1, 249-51, 1915). Oxidation in the air at room temperature was effected by Fahrion's method. The hydroxy acids of three grams of oil on ten grams of cotton yarn were determined after thirty days' exposure and found to be 38.4%. Oxidation at 70° was carried out in the apparatus of Genthe, and was complete in thirty hours. Oxidation in air at 150° was also carried out, according to Genthe, by heating in a beaker. The molecular weight rose in ten days from 710 to 1730, a fact which indicated polymerization or condensation along with the oxidation. The oil became solid and contained 31.8% hydroxy acids and 63% fatty acids soluble in petroleum ether, while the iodine number decreased to 64.8. Genthe states that siccatives are inactive in ultra violet rays, but Taverne, on the contrary, obtained complete oxidation in 45 hours. A lead manganese rosin compound containing 6.28% lead and 5.76% manganese was found to be the most active agent for hastening oxidation. On exposure to ultra violet light at 70° oxidation was complete with 5% siccative in 580 minutes.

Olive Oil.

Lesure (J. Pharm. chim., 7, 1,575-6) has observed that exposure of olive oil for an hour to ultra violet light caused an increase of more than 5% in the acidity.

Making Fatty Acids from Petroleum.

A process of deblooming hydrocarbons and converting them into fatty acids and esters is described by *Gray*, (U. S. patent 1,158,205, Oct. 26, 1915). The apparatus recommended (see Fig. 2) consists of a horizontal cylindrical still in which the hydrocarbon oil to be treated is placed. From the inner top portion of this still is suspended a row of lamps emitting ultra violet rays. The burners are in close contact with the surface of the oil, usually from two to six inches above the oil. A perforated coil is located on the bottom of the still for the admission of air, oxygen or ozone. Slightly above this perforated coil is a screen which carries catalytic material such as metals, their bases or salts, supported on porous granular material. The still may be heavily constructed to work under pressures up to five atmospheres.

In the deblooming operation, the oil (lubricating oil. paraffin wax, etc.,) is heated to from 50 to 120° C. by means of a high pressure steam coil. The oxygen-carrying gas is then forced through the oil, agitating the latter and in so doing exposing continuously new portions of the oil to the action of the ultra violet light. In the production of esters or fatty acids the temperature is maintained at from 90° to 175° C. and the process carried on as for deblooming. Samples of oil may be drawn from time to time to determine the progress of the reaction. The length of time required for the treatment will depend upon the hydrocarbons being treated, as these vary in their susceptibilty to oxygenation or esterification. Gray states that he has been able to convert 75% of a given quantity of hydrocarbons into fatty acids by this process. The catalyzers which he especially recommends for use in this process are caustic soda or caustic potash. In one instance a 220-volt mercury vapor lamp was placed four inches from the surface of the oil which was gently agitated with air. In this case it required approximately eight hours to debloom a depth of three inches of oil covering a surface of one square foot per lamp. In treating oils for deblooming it is stated to be essential that the temperature be kept below 100° C., otherwise discoloration of the oil will be brought about, making it unsuitable for use without further purification. The temperature is usually maintained by the heat derived from the lamps and in some cases it is even necessary to pass cooling water through the coil in the still.

Cracking Mineral Oils.

The Continental Caoutchouc and Gutta Percha Co. (French patent 469,948, March 21, 1914) produce lighter oils from high boiling fractions of mineral oil by the following method: The fraction of high boiling point is heated with a catalyst such as aluminum chloride, with or without mercuric, ferric, vanadium, or other chloride, or with aluminum in a stream of dry hydrochloric acid gas. It may be exposed in the form of spray to ultra violet rays or to the silent electric discharge in presence of a catalyst. The process is continuous. Gaseous products may be obtained by heating to a higher temperature in closed vessels.

Linseed Oil—Uviol Oils.

Genthe (German patent 223,419, Aug. 24, 1907; Scientific American, 1908, 255) offers a process of bleaching linseed oil, etc., by the action of short wave light and oxygen. The process is carried out by mixing the material intimately with air and allowing short wave light to impinge on the mixture. A mercury vapor lamp which produces ultra violet rays in abundance is made of a special glass which transmits waves as short as 253 millionths of a millimeter. Twenty ultra violet lamps are immersed in a tank containing one ton of crude linseed oil, heated to 176° F., into which air is simultaneously introduced in fine bubbles. Under the influence of the ultra violet rays the oil absorbs one twentieth of its weight of oxygen and becomes colorless, brilliant and limpid. The air is forced through the oil by a pressure equivalent to 10 feet of water. A stirring device provided with hollow arms through which the air may be blown is also used, to agitate the oil. It is stated that 1,000 kilos. of linseed oil can be bleached with an expenditure of 60 kilowatt hours for current, and 1,500 cubic meters of compressed air, under a pressure of 0.3 atmospheres, the total cost being stated to be about two dollars. Genthe (Chemical Technology and Analysis of Oils, Fats and Waxes, Lewkowitsch, Vol. 11, 1914, 33) also bleaches linseed oils with the Cooper-Hewitt mercury lamp for purposes of varnish manufacture; he also prepares "boiled oil" by exposing raw linseed oil to the ultra violet light of an "uviol" lamp. Recently, vegetable oils, stated to have been bleached by exposure to ultra violet rays, have been placed on the market under the name of "Uviol oils;" no published information as to these oils is available however.

Action of Ultra Violet Light on Varnishes.

In the writers' laboratory a large number of samples of varnishes of various grades have been exposed to the action of ultra violet light to determine its bleaching activity. The behavior of varnishes when subjected to the light varies greatly, depending on their composition. Some samples were considerably bleached, while others were darkened, others showed no effect. Some samples formed a heavy skin over the top. One sample especially, became almost solid after an exposure of eight to ten hours in one-half inch layers. In some cases the varnish was floated on a layer of water to prevent overheating. In other cases the samples were enclosed with the lamp in a chamber and inert gases or steam passed through the chamber during the light treatment. There did not appear to be any great difference in results when taking these precautions as compared with samples exposed to the atmosphere. Samples of linseed oil were also exposed under the same conditions. In most cases the oil was considerably bleached and with raw oil, practically no skin was formed over the top. With boiled oil, a film was formed on exposing linseed oil to the action of the light for six hours, when free access of air was allowed. In one case where the oil was exposed in a thin layer over water, the oil became turbid and apparently a very stable emulsion was formed. In another case a sample of raw oil was exposed for seven hours in a closed chamber in an atmosphere of steam. The oil, which was quite dark at the beginning, was bleached to a light straw color.

Asphalt.

In the action of light upon asphalt, which makes the latter more insoluble, *Gödrich* (Monatsh. 1915, *36*, 535) asserts that oxygen plays the role of a catalyzer. By the action of sulphur chloride upon asphalt the light insensibility is increased, but this is not proportional to the per cent. of sulphur in the different varieties. Solutions of asphalt show absorption bands in the blue and the yellow, but in the asphalts containing sulphur the latter are lacking. Asphalt is sensitive towards monochromatic light for the entire range of the spectrum and into the ultra violet.

Cumaron Resin.

Cumaron resin, produced by treating solvent naphtha with sulphuric acid, on exposure to ultra violet light for a period of three hours at a distance of a few inches from the light, was sensibly darkened. (J. Ind. Eng. Chem. 1916, 800.)

Synthetic Resins.

Mathews and *Elder* (British patent 11,635, 1914, J.S.C.I., 1916, 192) claim that compounds of sulphur dioxide and unsaturated hydrocarbons (pseudobutylene, propylene, amylene, and ethylene) are polymerized on exposure to ultra violet light or by heating. The butylene body gives a transparent film and renders celluloid less inflammable. A review of synthetic resins is given by Elder, (Kunstoffe, 1916, 6, 45) with special reference to the patent literature.

Polymerized Acrylic Acid Ester.

A substitute for drying oils as a medium for paints, varnishes, and impregnating agents for fabrics, wood, etc., proposed by *Rohm* (J.S.C.I., 1917, 296, German patent 295,340, June 5, 1915) consists of a solution of polymerized acrylic acid ester, in acetone, lower fatty esters or other solvents. The acrylic esters may be prepared from allyl alcohol, glycerine, lactic acid, etc. When exposed to sunlight or ultra violet light, they are transformed into a colorless, transparent, very elastic (not gelatinous) tough mass, which is soluble in solvents for oils. Alternatively the ester may be mixed with a solvent, and the mixture polymerized. The polymerized ester dries rapidly, resists many chemical agents and is not readily affected by exposure to weather.

Fabric-Staining Oils.

In order to ascertain the liability of oils to stain textile fabrics *Gray* (Oil, Paint & Drug Reporter, Aug. 9, 1915) proposes to expose pieces of tape, treated with the oils, to the light from a Cooper Hewitt quartz lamp, using a standard oil for purposes of comparison. A half hour exposure at a distance of six inches from the lamp, was found to be sufficient to develop a stain with oils likely to discolor fabrics.

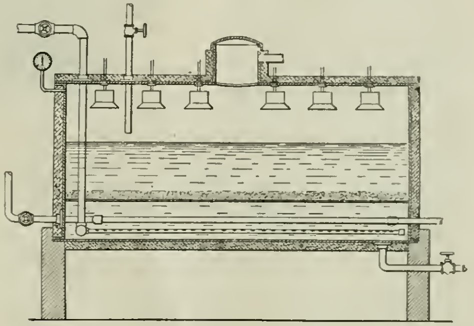


Figure 2.—Gray's Apparatus for Conversion of Hydrocarbons Into Fatty Acids.

Hydrogenation of Oleic Acid.

The effect of the rays from an iron arc on the hydrogenation of oleic acid is described by *Curtis* (Journal of Franklin Institute, 1917, 880). The oleic acid was placed in a quartz flask which was fitted with a long air condenser and hydrogen gas was passed in. The arc was placed 1.5 centimeters from the flask and the exposure continued for six hours, when the degree of hydrogenation was determined by the iodine numbers. It was concluded that there was no acceleration in hydrogenation of oleic acid due to the action of the light. Experiments performed without illumination showed that the amount of saturation was practically equivalent in each case.

Oven dried lacquered leather, before further drying, is exposed by Heyl (Chem. Abs. 1917, 2417; Holland patent 1,970, May 15, 1917) to the action of artificial light rich in ultra violet rays and to ammonia vapors.

Patent Leather.

Lumbard, (J. Am. Leather Chem. Assn., 84, 1915) discusses the use of ultra violet in the manufacture of patent leather. It is claimed that the exposure of the varnished surfaces to the action of mercury vapor lamps gives the same result in one and one-half hours as is obtained by several days' exposure to sunlight. Lumbard claims that better results are obtained if the extreme ultra violet rays are filtered out.

(To be continued in the February issue.)

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.

ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

O. A. S.—Sandarac, which gives the characteristic odor you find in testing, is due to that type known as Callitris quadrivalvis. Callitris verrucosa contains Pinene and therefore will not evolve the same odor.

A. B. T.—The ochre sample received from your miner has been submitted to careful chemical analysis, but I am sorry to report that it cannot be used for the purpose you mention. Its chief use will be found in the window shade and low grade paper lines.

A. A. F.—Your trouble is due to too high a content of sulphur while vulcanizing. This always cause the cracking you mention. The sample you sent me contained such a high percentage as to make it extremely brittle. I would strongly recommend you to reduce this constituent at once or your product will be in no way merchantable.

M. S. D.—The reason your mashes are not fermenting dry enough is because your enzymic conversion has been impaired by too high a content of acid. You had better add a little active diastase directly to the mash after first reducing the acidity to at least 0.12%.

Send me samples of each batch for investigation as to the transformation of the starchy matter and acidification.

H. R. T.—The formulae of the minerals you mention in your last letter are given below. Regarding those you are about to forward me for complete analysis, would state that absolute representative samples should be taken, by the usual method of quartering, etc., and one pound quantities sent me.

Microcline	$KAlSi_3O_8$
Sillimanite	Al_2SiO_5
Zircon	$ZrSiO_4$
Rutile	TiO_2
Orthoclase	$KAlSi_3O_8$

I. J. R.—Ruthenium is practically insoluble in all acids and aqua regia. Its detection may be accomplished by fusion with potassium hydroxide and potassium nitrate, when the resulting K_2RuO_4, heated with NaCl in a current of chlorine yields soluble K_2RuCl_6. This greenish-black fusion gives with water an orange-yellow solution which stains the skin black.

F. J. T.—Your statement is incorrect. The natural coloring and essential oils of flower can be extracted by a cold process and when so obtained make an excellent toilet water or mouth wash. The cost of production, aside from the flowers themselves (which cost is little in certain seasons), is quite small, and no alcohol is required as a preservative.

F. S.—A chemical analysis is by no means a working formula; the first simply states the general composition, while the latter gives detailed instructions as to the commercial production.

Forward me the product and I will reproduce it and supply the working details within a week.

J. W. K.—I am sending you by mail the complete chemical analysis of the medicine labeled "CACHETS." This is used principally for locomotor ataxia, and since it contains very powerful drugs, I strongly advise you to consult a physician before using same.

G. F.—It will be necessary for me to charge you a small fee for the determinations of nitrogen in the various samples of explosives you propose sending me, on account of the care involved and the special apparatus required. A half-ounce sample of each will be ample for these tests.

Charles B. Davis.

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail are specifically requested, communications can only be considered in the order of their receipt.—Editor.

EDITORIAL COMMENT

1918

The coming year promises to be the most critical in the history of our country. It will see the American nation enlisted in the Titanic world struggle as its most powerful factor. All eyes are turning in our direction. Of the the ultimate outcome of the conflict there can be no doubt. But it depends upon the efforts of the American people, during 1918, to demonstrate this fact so forcibly and clearly that our foes will realize the utter hopelessness of continuing further the terrible expenditure of blood and treasure, and the uselessness of prolonging the indescribable misery in which so many millions in Europe and Asia are despairingly plunged.

This year applies the acid test to American bravery, fortitude, resoluteness and resourcefulness. The efforts which we will put forth are bound to insure the coming generations of our nation from all danger of attack by a highly organized militaristic empire, unscrupulous in its methods, pitiless and remorseless in its viewpoint. But they will accomplish far more beyond our own borders in bringing that same assurance to the other nations of the world accepting the same standards of duty, of humanity and of civilization.

Every additional accomplishment on our part, shortening the war by a single day, is equivalent to lessening by millions the world's indebtedness, to saving thousands of lives, to ending a day sooner the enormous sum of physical and mental suffering, enveloping as a grim pall scores of millions of our fellow beings.

The year 1918 will demand the maximum of resolute, strenuous effort, as well as of prompt and cheerful sacrifice, on the part of every class and category in our population.

To the chemists of this land the demand comes with greater insistence than probably to any other class, for the war is emphatically a contest of chemists and engineers.

Our chemists are responsible for the quality and the prompt output of the munitions consumed in such huge quantities. We depend upon them to assure the fertility of our fields, now so heavily taxed, to assure the quality and supply of the iron and steel and other metals used in the manufacture of arms, to provide the drugs and supplies for a vast hospital service, the gases and liquid fire for trench warfare, to facilitate the conservation of our food supply.

At every step the chemist is directly or indirectly an indispensable cog in the gigantic military machine which we are forced to organize, so contrary to the inclinations and ambitions of a powerful but peaceful people.

Well may we be proud of what American chemists have accomplished during the past three years in solving purely economic problems. With far greater pride shall we look back upon their achievements at the end of the war, realizing to what an extent the final result will be due to their individual and combined efforts.

The German Dye Trade After the War

German economists are devoting an increased amount of attention to the problems facing the Empire's foreign trade relations at the close of the war. It is felt that every possible preparation must be made to reestablish the manifold commercial ties which connected Germany, four years ago, with the rest of the globe.

The stocks of foreign raw materials in Germany have long since been exhausted, and it will involve the expenditure of vast sums to secure needed supplies from every quarter to set the wheels of industry again in normal and continuous motion. The financing of this trade movement will evidently be a serious problem. If the heavy gold reserves of Germany can be utilized for this purpose, it would simplify conditions. That is, however, not probable, in view of the enormous issues of paper money, now in circulation; and based upon the relatively small amounts of metallic reserves in the banks. The great importing houses trust to a renewal of their former widespread connections in foreign lands, and a revival of the credit formerly existing, which would lead to a better regulation of payment and a distribution over longer periods of time. The extent of this credit is, however, of a very uncertain nature, and it unquestionably is lessening with every additional week of warfare.

The strongest emphasis is laid upon the export of products made from German raw materials. In this category stand prominently artificial dyestuffs and potash. It is regarded as highly desirable that the coal-tar color industry, now devoted largely to the manufacture of munitions, should be switched back to its normal activities, at the first signs of peace. By pushing to the utmost the sale of its products in all countries, it is hoped that credits can rapidly be established which will facilitate the purchase on a vast scale of the various textile fibres, the caoutchouc, the many tropical products, the hides and skins, the tin, the copper, oils and all the other supplies required by Germany's highly diversified industries.

In this plan there are, however, many factors of uncertainty. The dyestuff industries of Great Britain, France, the United States and Japan are being rapidly perfected. The domestic demands in these lands are being met with constantly increasing degrees of satisfaction as regards quality, variety and quantity. Exportation of dyes to other lands has begun on a modest but promising scale.

In our own country, a year hence, the field will be occupied so thoroughly that it is extremely doubtful whether any material amount of German colors can find a ready sale. Quite a number of the costlier colors, consumed in relatively limited quantities, will certainly be sought with eagerness. But it is questionable whether the German dye manufacturers to-day could sell over a quarter of the product which four years ago they shipped to the United States. In European countries and their colonies, for sentimental reasons, the proportion may be even less. Should the war continue for two or three years longer, the possibilities of recovering the lost trade will shrink to small dimensions.

Much the same may be said as to the reliance on German potash for a rapid recovery of foreign credits. In every part of the world efforts are being directed to utilize the varied potash occurrences, individually of restricted value, representing in the aggregate, however, enormous amounts.

Numerous economic organizations have been formed in Germany during the war, in which the purchase of supplies has been centralized and this has done much to prevent prices from rising to extravagant figures. It is doubtful whether their activities will cease at once with the arrival of peace. Powerful syndicates for controlling sales, especially in the export trade, existed before the war. They will undoubtedly be strengthened in the effort to recover the Empire's lost trade. The consolidation of the great dyestuff companies for this very purpose, is the most striking illustration of what will be the general commercial policy of Germany.

The American Color Industry

What better proof of the substantial growth of the American coal-tar color industry can be asked than that afforded by the extent of our exports of artificial dyes for the third quarter of 1917? The value of these exports for the three months was $1,173,439. This is equivalent to an annual export of about $4,700,000. Assuming that prices are five times the pre-war rates, we can claim to have reached the point where we can ship abroad, annually, coal-tar colors worth $1,000,000, while meeting the bulk of domestic demands, as compared with annual imports prior to the war valued at $10,000,000, and a domestic output (made from foreign intermediates) valued at about $3,000,000.

The figures are eloquent! We are still far from producing the variety of synthetic colors which our dyes need, but as far as quantity goes the industry is certainly on a very stable basis, and twenty-one foreign countries are securing supplies from us.

The National Synthetic Company, Fords, N. J., has awarded a contract for the construction of three new additions to its chemical manufacturing plant.

American Color Manufacturers Agree to "See It Through"

(Concluded from page 106)

Warehouse Mercantile Co., 24 State street, New York.
Kuttroff Pickhardt Co., 138 Duane street, New York.
A. & B. Export & Import Corp., 87 Wall street, New York.
Hydro Carbon Cheml. Products Co., Cardington, Pa.
Herman & Herman, Inc., 6 Church street, New York; *James R. Edwards, treasurer.*
United Chemical Products Corp., York and Colgate streets, Jersey City, N. J.; *C. T. Hamilton, president.*
United Aniline & Chemical Works, Inc., 377 Broadway, New York; *L. Araps, secretary.*
Century Colors Corp., 182 Front street, New York; *Otto L. Obermaier.*

Inorganic Chemical Synonyms

(Concluded from page 112)

Rock Alum
Bauxite (native)
Aluminum Sulfate. 342.41
Alumini Sulfas
Aluminic Sulfate
Concentrated Alum
Cake Alum
Patent Alum
Neutral Sulfate of Aluminum
Sesquisulfate of Aluminum
Vitrolate of Aluminum
Aluminum Potassium Sulfate. 949.06
Potassic Aluminic Sulfas
Alumen
Alum
Alum Meal
Alum Flour
Cube Alum
Common Alum
Potash Alum
Potassium Alum
Sulfate of Aluminum and Potassium
Octahedral Alum Salt
Aluminite (native)
Dried Potassium Aluminum Sulfate. 517.06
Alumini Exsiccatum
Alumini Ustum
Burnt Alum
Dried Alum
Exsiccated Alum
Double sulfate of Aluminum and Potassium
Roman Alum

The Benzol Products Company.

The Benzol Products Company has surrendered its charter and ceased to exist as a separate corporation. This act is a natural sequel to its entry, last summer, into the general merger, constituting the National Aniline and Chemical Co., Inc.

The Company was organized in 1910 by representatives of the General Chemical Co., the Barrett Co., and the Semet Solvay Co.

It successfully established the manufacture of aniline on a large scale in this country, and has been a powerful factor in supplying large quantities of aniline and other coal-tar intermediates to our color industry during the past two years of expansion.

THE CHEMICAL ENGINEER

VOL. XXVI. FEBRUARY, 1918 No. 4

Published Monthly by the
McCready Publishing Company.

ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, FEBRUARY 1918

The Detection of Resin in Drier........................122
E. W. Boughton

Relation Between Composition and Density of Aqueous Solutions of $CuSO_4$ and H_2SO_4............125
H. D. Holler and E. L. Peffer

"Cost Accounting for Oil Producers"..................128
Dr. Arthur H. Elliott Passes Away.....................128
Deferred Classification for Chemists of Draft Age....129
Coal-Tar Chemistry Section...........................131
Edited by Thomas H. Norton

Under which is included:
  Industrial Reconstruction 131
  German Propaganda? 132
  Indanthrene Colors in England.....................132
  The Evolution of Artificial Colors.................133
  Recent Studies in Color Chemistry................138

Cold Facts on a Warm Subject........................142
Ultra-Violet Light: Its Application in Chemical Arts. Part XI 143
Carleton Ellis and A. A. Wells

Inorganic Chemical Synonyms. Part II..............151
Elton R. Darling

Chemical Investigation, Efficiency and Control........153
Conducted by Charles B. Davis

New Equipment and Apparatus........................154
  Link's Stationary or Superimposed Water Still.
  —An Unusual Design for Distillation and Evaporation.
  —The Hess-Ives Tint Photometer.

New Publications 157
Foreign Trade Opportunities.........................159
Distillates 160

The Export of American Chemical Products

The outward movement of American chemicals has steadily grown during 1917. For the month of September the increase was from $15,344,000 in 1916 to $16,415,000 in 1917.

For the first three quarters of the year comparative figures are as follows:

1915	1916	1917
$54,056,000	$121,085,000	$141,204,000

There seems to be no question but that permanent markets are being steadily gained by American manufacturers in all parts of the world, from which it will be difficult to dislodge them when international exchanges are resumed.

The matter of chief importance, in the meantime, is to so assure the quality of American chemicals that they may be regarded in foreign countries as absolutely reliable in regard to purity and strength.

Neglect in this respect, here and there, on the part of a few careless exporters, may have disastrous results for the entire industry.

The Badische Co. of New York

This company, representing in the United States the famous Badische Anilin-und Soda-Fabrik of Ludwigshafen on the Rhine—known familiarly as "the Badische"—is now superseded by a new organization, Kuttroff, Pickhardt & Co. The latter takes over the entire staff of its predecessor, with its laboratories and branch agencies in Boston, Providence, Philadelphia, Chicago, San Francisco, Goldsboro and Montreal. The new designation recalls the original name of this great distributing agency before it was incorporated as "The Badische Co."

It is probable that sound business reasons dictated the dropping of the recent title, so distinctly German in its associations. The same reasons, with equal probability, caused the recent formation of the Century Color Co., which absorbed the technical and sales staff of the Cassella Color Co. of New York.

THE DETECTION OF RESIN IN DRIER

By E. W. Boughton*

In the Following Paper the Writer Tells How a Method Was Developed for the Detection of Resin in Driers Which Is Reliable Except When the Resin Content Is Very Small, for Example, Less Than Six Per Cent. of the Ash-Free Non-Volatile Portion.

INTRODUCTION.

In the preparation of paint by the painter a drier is added to hasten the drying. Common practice is to add about 5 parts by volume to 95 parts of oil. Commercial driers show on analysis from 2 to 10 per cent. of ash, containing lead, manganese, and sometimes calcium, and from 60 to 95 per cent. of volatile thinner, usually consisting of turpentine, mineral spirits,[1] or a mixture of the two. In addition to the above, what is known as "oil drier" contains linseed oil but no resin, while "japan drier" contains both linseed oil and resin.[2] This distinction, however, is not strictly adhered to in the paint trade. Sometimes oil driers and japan driers are sold under other names, and there are also on the market many special and patent driers which are not used for general painting work. The resin is added to the drier to prevent precipitation of metallic soaps after thinning and to decrease the tendency of the drier to "curdle" with oil. Oil driers are made, however, containing as much as 95 per cent. of mineral spirts, which contain sufficient lead and manganese to show satisfactory drying properties in laboratory tests.

The usual laboratory examination of driers includes the determination of the amount and nature of the volatile thinner, the amount and nature of the ash, a qualitative test for rosin, and drying tests with linseed oil. Purchasers of oil driers presumably desire material that is free from resins, and therefore a method for the detection of resin is needed.

THE SIGNIFICANCE OF RESIN IN DRIER.

The following statement appears in "One Thousand More Paint Questions"[3]:

> Japan driers differ from oil driers in so far as the first named are composed of gums or resins fused with linseed oil and driers such as litharge, red leaf, and manganese salts. * * * Oil driers are, or should be, used for oil paints for exterior work, because, being free from resinous substances, they tend less to the cracking of paint than the excessive use of japan driers, while on the other hand the latter should be employed where quick drying, as in flat or semiflat paints, is an absolute necessity and where surfaces are not exposed to severe weather conditions.

This statement probably expresses the ideas of those who prefer oil drier. The condemnation of "the excessive use of japan driers" is undoubtedly justified, but it is highly improbable that the small amount of resin introduced into a paint by the addition of 5 per cent. of japan drier would have any bad effect for outside paints. On the contrary, Dubois[4] showed that the addition of small amounts of "kauri mixing varnish" to linseed oil produced a vehicle that was superior to pure linseed oil for paints for iron and steel, the films being less pervious to water vapor and other gases. Toch,[5] in a summary of the results of exposure tests of painted steel plates on which different vehicles were used, includes spar varnish and a mixture of spar varnish and "stand" oil[6] in the class which showed "a high degree of protection against corrosion." The general use of spar varnish for exterior work on metal and wood and the practice of adding spar varnish to paint vehicles indicates that the presence of resin, when the amount is not excessive, is beneficial.

In answer to an inquiry from the Bureau of Standards, several manufacturers of driers gave their opinions regarding the classification and relative values of oil drier and japan drier. All stated that while the distinction between the two as given above is technically correct it is very frequently disregarded, and that while the amount of oil drier that is made and sold is considerable it is small in comparison with the amount of japan drier that is used. Only one manufacturer claimed that oil drier is preferable to japan drier, his statement being as follows: "Except for certain purposes a high-grade oil drier is to be preferred to a kauri japan drier." The same manufacturer stated that if rosin is present in a drier, the amount should be limited. With this exception, no manufacturer stated that the presence of rosin or mineral oil has any bad effect. One manufacturer called attention to the fact that driers (called by him "resinate driers") are used, the non-volatile organic portion of which is composed entirely of resin.

Ordinarily the judicious use of japan drier will introduce from 1 to 2 per cent. of resin into a paint and there appears to be no proof or general agreement among paint technologists that this small amount has any bad effect. It is improbable that its presence or absence makes any noticeable difference in painting results.

---

[1] The term "mineral spirits" is being generally accepted for the petroleum distillates that are used as substitutes for turpentine.

[2] In the paint trade the resins, other than rosin, are called "gums."

[3] Published by The Painters' Magazine, New York (1908).

*Associate Chemist U. S. Bureau of Standards. From a Technologic Paper published by the Bureau.

[4] J. Ind. Eng. Chem., 5, p. 968 (1913).

[5] J. Ind. Eng. Chem., 7, p. 510 (1915).

[6] Linseed oil, heated and allowed to stand in tanks for three to four weeks.

Although very good spar varnishes are made which contain small amounts of rosin, the presence of a large amount in a paint vehicle makes the latter unsuitable for outside work, and since no data are available to show the maximum amount which may be present without lowering the quality, specifications for driers and for outside varnishes almost always prohibit the use of rosin.

EXPERIMENTAL.

Preparation and Collection of Samples.

The composition of the driers used in this investigation is shown in Table 1. The sample designated as No. 1 was prepared from linseed oil, litharge, manganese dioxide, and turpentine; No. 2 from these materials and kauri. Nos. 3, 4, and 5 were prepared from linseed oil, litharge, and manganese dioxide, no thinner being added. After all the oxides had been added to the heated oil, the mixtures were heated at 250-300° C for one-half, one, and two hours, respectively. Nos. 6, 7, and 8 were made in the same way as were Nos. 3, 4, and 5, except that red lead was substituted for litharge and the samples were thinned with turpentine. Seven more samples, Nos. 9 to 15, inclusive, were prepared from various resins and oils, manganese dioxide, lithrage, and turpentine, the mixtures of oil, resin, and oxides being heated for one hour at 250-300° C. Nos. 16 to 39, inclusive, were obtained from manufacturers[7], the data regarding the composition of these samples being compiled from the statements of the makers. In the preparation of commercial driers, the mixtures of oil, resin, and metallic compounds are heated for so long a time and at so high a temperature that the percentages of oil and of resin in the finished driers can be only approximately estimated.

Preliminary Experiments.

Rosin can be detected, of course, by the well-known Liebermann and Storch test with acetic anhydride and sulphuric acid. Attempts to identify and detect other resins by the color test of Hicks[8] were not successful. Determination of the acid number of the mixtures of unsaponifiable matter, fatty acids, and resin acids, obtained from the driers by saponification and subsequent treatment with acid, was found to be useless as a means for the detection of resin, because prolonged heating during the preparation of oil drier lowered the acid number very much. For instance, the mixtures of unsaponifiable matter and fatty acids obtained from Nos. 3 and 5 (heated for one-half and two hours, respectively) showed acid numbers of 186 and 165, respectively.

Detection of Resin by the Alcohol Method.

The mixtures of unsaponifiable matter, resin acids, and fatty acids, obtained from the driers as stated above, were treated with ethyl alcohol of two strengths, 95 and 97 per cent. by volume. In most cases the samples containing resins other than rosin showed a marked turbidity or a deposit of insoluble matter. It will be noted from the results of these tests, as shown in Table 1, that to obtain clear solutions with Nos. 6 to 8, inclusive, it was necessary to use 97 per cent. alcohol. With these samples the use of 96 per cent. alcohol gave solutions that were very faintly turbid. It will be noted also that by this method it was impossible to detect the presence of rosin, manila, shellac, and the very small amounts of kauri that were present in Nos. 34 to 36, inclusive.

TABLE 1

Detection of Resin by Alcohol Method

No.	Constituents other than thinner and metallic oxides		Name of drier given by manufacturer	Appearance of alcohol solution	
	Per cent of oil	Per cent of resin		95 per cent alcohol	97 per cent alcohol
1	Linseed, 48	None		Clear	
2	Linseed, 38	Kauri, 8		Turbid	Turbid.
3	Linseed, 85	None		Clear	
4	do	do		do	
5	do	do		do	
6	Linseed, 45	do		Turbid	Clear.
7	Linseed, 47	do		do	Do.
8	Linseed, 48	do		do	Do.
9	Linseed, 25; Chinese wood, 12	do		Clear	
10	Linseed, 26	Kauri, 6		Turbid	Turbid.
11	do	Manila, 5		Clear	Clear.
12	Linseed, 28	Manila, 8		do	Do.
13	Linseed, 30	Dammar, 6		Turbid	Turbid
14	Linseed, 27	Rosin, 7		Clear	
15	Linseed, 25	Shellac, 5		do	
16	Linseed	Rosin	Japan	do	
17	do	None	Oil	do	
18	do	do	do	do	
19	do	"Copal gum"	Gum	Turbid	Do.
20	do	Rosin	Resin	Clear	
21	Linseed, 50	None	Specification	do	
22	Linseed, 12	Kauri, 10		Turbid	Do.
23	Linseed, 27	Rosin, 7	High-grade commercial.	Clear	
24	Linseed	"Vegetable gum."	Coach painters' japan.	Turbid	Do.
25	Linseed	None	Standard japan	Clear	
26	Linseed, 18	"Fossil gum," 14.	Japan	Turbid	Slightly turbid.
27	Linseed, 22	None	Oil	Clear	
28	Linseed	do	do	do	
29	do	Kauri	Japan	Turbid	Turbid.
30	do	Kauri, Resin	do	do	Do.
31	do	Rosin	do	Clear	
32	do	do	do	do	
33	do	do	do	do	
34	Linseed, 25	Kauri dust, 1½.	do	do	
35	Linseed, 28	Kauri dust, 1	do	do	
36	Linseed, 26	Kauri dust, 1½.	do	do	
37	None	Rosin	Resinate	do	
38	Linseed	None	Linoleate	do	
39	do	do	do	do	

Detection of Resin by Esterification and Subsequent Determination of the Acid Number.

The usual method for the determination of oil and resin in mixtures of the two includes esterification by Twitchell's[9] method, using absolute alcohol and dry hydrochloric acid gas, or by Wolff's[10] method, using absolute alcohol and concentrated sulphuric acid. Preliminary experiments with fatty acids prepared from linseed oil, the results of which are shown in Table 2, showed that more nearly complete esterification was obtained by the former method, absolute ethyl alcohol being used. As is also shown in Table 2, variation of from two to five minutes in the time of heating in the Wolff method did not affect the results obtained with the mixtures of acids and unsaponifiable matter from oil drier and japan drier. The Wolff method is shorter and simpler than the Twitchell method, and the results obtained with various samples of driers, as given in Table 3, show that as a qualitative test for resin the former is satisfactory. The maximum figure for acid number after esterification was 9 for oil driers and the minimum figure for japan driers was 11. Since the figure obtained with No. 34 is within experimental error of the maximum figure for oil drier, the method can not be depended upon to detect less than 6 per cent. of resin in the ash-free nonvolatile portion of a drier. This is ordinarily equivalent to a resin content of less than 3 per cent. in a thinned drier ready for use. The figures obtained with driers are given as whole numbers because the end point of the titration, using phenolphthalein as indicator, was so obscured as to cause a possible error of 0.1 cc of 0.25 N alkali. This would result in an error of 1.4 in the acid number determined with a 1 g sample. In fact, an accuracy of two in the determination of acid number is all that can be expected. Samples that weigh over 1 g can not be used since the solutions would then be too dark in color.

---

[7] For samples and information the author is indebted to the following: John Lucas & Co., Inc.; W. P. Fuller & Co.; Samuel H. French & Co.; Pitcairn Varnish Co.; Pratt & Lambert; Sherwin-Williams Co., and the O'Brien Varnish Co.

[8] J. Ind. Eng. Chem., 3, p. 86 (1911).

[9] J. Soc. Chem. Ind., 10, p. 804 (1891).

[10] Chem. Ztg., 38, pp. 369-370, 382-383, 430 (1914).

TABLE 2

Results with Twitchell and Wolff Methods of Esterification

Material	Method	Time of heating	Acid number (mg. of KOH per gram of acids + unsaponifiable matter)
		Minutes	
Fatty acids + unsaponifiable matter from raw linseed oil....	Twitchell....	....	2.7 3.3
Average..	....	....	3.0
Fatty acids + unsaponifiable matter from raw linseed oil....	Wolff.........	2	6.6 5.7
Average...	....	....	6.2
Fatty acids + unsaponifiable matter from oil drier, No. 8.....	Wolff.........	2 3 5	8 8 7
Fatty acids + resin acids + unsaponifiable matter from japan drier, No. 12........	Wolff.........	2 3 5	19 18 19

PROPOSED METHOD FOR THE DETECTION OF RESIN IN DRIERS.

(1) Test for rosin by the Liebermann and Storch method with acetic anhydride and sulphuric acid.

(2) If no rosin is detected by (1), place about 25 cc of the drier in a flask and pass in a rapid current of steam while heating the flask in an oil bath at 130° C. Add an excess of alcoholic potash, and heat on the steam bath for one hour. Add an excess of hydrochloric acid and shake vigorously. Fill the flask with hot water and allow the oily layer to collect in the neck of the flask. Remove about 5 cc of this oily layer to another flask, add about 25 cc of dilute hydrochloric acid (1:1), and boil for a few minutes. This is necessary to insure the decomposition of all metallic soaps. Cool, add about 20 cc of ether and sufficient water to bring the ether solution into the neck of the flask. Filter a portion of this ether solution into a flask, evaporate off the ether, and dry the residue at 110-115° C for one-half hour. Place 0.15-0.20 g of this residue in a test tube, add 5 cc of ethyl alcohol (97 per cent. by volume), and shake. A turbidity or a deposit of insoluble matter shows the presence of resin in the sample.

(3) If no resin is detected by (1) or (2), filter into a tared flask a sufficient amount of the ether solution obtained in (2) to yield a dry residue of 0.8—1.0 g. Evaporate and dry as stated under (2) and weigh the flask and dried residue. Add 10 cc of absolute ethyl alcohol, warm gently till the solution is clear, and add a mixture of 10 cc of absolute ethyl alcohol and 3 cc of concentrated sulphuric acid. Boil under a reflux condenser for two or three minutes, cool and transfer the contents of the flask to a separatory funnel, washing out the flask with water and ether. Add 25 cc of a 10 per cent. solution of sodium chloride and shake. Draw off the lower layer and shake it with 50 cc of ether. Unite the ether solutions and wash with water until the washings are neutral. Three washings will usually suffice. Transfer the ether solution to a large flask and dilute with neutral 95 per cent. alcohol until the color of the solution is sufficiently light to permit of titration with 0.25 N alcoholic potash, using phenolphthalein as indicator. Dilution to 400—600 cc is generally necessary. If the dilution with alcohol causes a turbidity, add sufficient ether to clear the solution. Titrate with 0.25 N alcoholic KOH and calculate the acid number as milligrams of KOH per gram of the mixture of unsaponifiable matter and acids taken. An acid number of over 10 shows the presence of resin in the sample.

TABLE 3

Results with Driers, using Wolff Method of Esterification

Sample		Acid Number	Average.
Oil drier No. 6; linseed oil, 45 per cent..........		9 7	8
Oil drier No. 7; linseed oil, 47 per cent..........		8 8	8
Oil drier No. 8; linseed oil, 48 per cent..........		7 7	7
Oil drier No. 8a[a]..........		9 7	8
Oil drier No. 27; linseed oil, 22 per cent..........		9 8	8½
Japan drier No. 10	linseed oil, 26 per cent.......... kauri, 6 per cent..........	13 13	13
Japan drier No. 11	linseed oil, 26 per cent.......... manila, 5 per cent..........	14 18	15
Japan drier No. 12	linseed oil, 28 per cent.......... manila, 6 per cent..........	19 18	18½
Japan drier No. 15	linseed oil, 25 per cent.......... shellac, 5 per cent..........	16 16	16
Japan drier No. 34	linseed oil, 25 per cent.......... kauri dust, 1½ per cent..........	11 11	11
Japan drier No. 35	linseed oil, 28 per cent.......... kauri dust, 1 per cent..........	13 15	14
Japan drier No. 36	linseed oil, 26 per cent.......... kauri dust, 1½ per cent..........	12 14	13

[a] No. 8 without thinner

SUMMARY.

A method has been developed for the detection of resin in driers which is reliable except when the resin content is very small, e. g., less than 6 per cent of the ash-free nonvolatile portion.

RELATION BETWEEN COMPOSITION AND DENSITY OF AQUEOUS SOLUTIONS OF $CuSO_4$ AND H_2SO_4

By H. D. Holler and E. L. Peffer[*]

INTRODUCTION.

In connection with an investigation on the regulation of solutions for electrodeposition, especially of acid copper sulphate solutions for electrotyping, it was found desirable to devise a simple method of determining and adjusting their composition. Since the solutions usually employed for the above purpose contain only copper sulphate and sulphuric acid, the composition of any given solution is fixed if the acid content and density at a given temperature are known. The density can be readily determined with a hydrometer, and the acidity can be ascertained with sufficient accuracy by titration with standard alkali, using methyl orange as indicator, as described by Wogrinz.[1] In order, therefore, to learn the content of copper sulphate, all that is required is a table showing the density of solutions containing known amounts of copper sulphate and of sulphuric acid.

Although the densities of solutions of copper sulphate and of sulphuric acid have been determined separately, no systematic study of the densities containing both could be found in the literature. Only in isolated cases were such data given concerning certain baths, such as those recommended by Pfanhauser,[2] Langbein-Brannt,[3] Steinach and Buchner,[4] and others.

The concentration of solutions containing both copper sulphate and sulphuric acid is limited by the fact that addition of sulphuric acid to copper sulphate solution causes a marked decrease in the solubility of the copper sulphate. Thus, while 395 grams of crystallized copper sulphate is contained in 1 liter of the saturated solution at 15°C, the addition of 100 grams per liter of sulphuric acid reduces the solubility of the copper sulphate to 215 grams per liter. Since in any practical work it is necessary to use solutions somewhat removed from the saturation point, the actual field is probably included in the range of 0 to 20 per cent of each of the constituents. Such solutions, therefore, formed the basis of this investigation. The temperature range of 25° to 40°C was selected as including the normal temperature employed in most copper plating or refining operations. Doubtless the expansion coefficients determined from such data will permit extrapolation over a moderate range above and below the temperatures used.

METHOD OF INVESTIGATION.

Preparation of Solutions.

In order to avoid the influence of temperature in the preparation of the solutions, they were all made of a known composition by weight, expressed in grams of each constituent per kilogram of solution. They were prepared in duplicate by mixing accurately weighed portions of water and of standardized concentrated solutions of copper sulphate and of sulphuric acid.

The stock sulphuric acid solution was prepared by diluting c. p. acid to about 12 normal with distilled water, and was standardized by the barium sulphate method with the usual precautions. It was also compared with a hydrochloric acid solution, standardized by silver chloride precipitation, through a solution of sodium hydroxide, using methyl orange as indicator.

The concentration of the sulphuric acid solution as determined by the barium sulphate method agreed with that obtained by comparison with the standard hydrochloric acid solution to within about 1 part of 1500. Weight burettes were used, the individual titrations agreeing to within less than 1 part in 2000.

The solution of copper sulphate was prepared from recrystalized salt, which gave a perfectly clear solution. The concentration of copper sulphate ($CuSO_4$-$5H_2O$) was calculated from the copper content determined electrolytically, the greatest difference between any two results being 1 part in 3000. Complete removal of copper from the electrolyte was confirmed by testing with $K_4Fe(CN)_6$.

Density Determination.

Method of Determination.—The density measurements were made by the method of hydrostatic weighing, i. e., by weighing in the sample under investigation a sinker of known mass and volume. The density[5] of the liquid is then calculated by means of the equation:

$$D_t = \frac{W - \dfrac{(w - w_1) + (w - w_2)}{2}\left(1 - \dfrac{p}{8.4}\right)}{V_t}$$

---

[1] Chem. Ztg., 37, p. 869; 1913.

[2] Die Galvanoplastik, p. 37-38; 1904.

[3] Electrodeposition of Metals, 7th ed., p. 574-575, 590; 1913.

[4] Die Galvanische Metallniederschläge, p. 160-161; 1911.

[*] Respectively Assistant Chemist and Laboratory Assistant, U. S. Bureau of Standards. From a Scientific Paper issued by the Bureau.

[5] Throughout this paper the term "density" is used to denote mass per unit volume and is here expressed in grams per milliliter. The densities are therefore numerically the same as specific gravities in terms of water at 4° C as unity.

in which

D_t = Density at temp. t
W = Mass of sinker in vacuo
w = Weighings with sinker off
w_1 and w_2 = Weighings with sinker on
p = Air density
8.4 = Assumed density of brass weights
V_t = Volume of sinker at temp. t

Apparatus Used.—The apparatus used is described in detail in Bureau publications (Technologic Paper No. 9 (1912) and Bureau of Standards Bulletin, Vol. 9, pp. 371-378 (1913). A short description of the apparatus is given, as follows:

TABLE 1

Density of Copper Sulphate—Sulphuric Acid Solutions

$CuSO_4.5H_2O$, g/kg	$CuSO_4$, g/kg	H_2SO_4, g/kg	Density,[a] 25° C	Mean density, 25° C	Density, 40° C	Mean density, 40° C	a[b]
50 50	31.97 31.97	0 0	1.03014 1.03017	1.03016	1.02489 1.02488	1.02488	−0.00035
50 50	31.97 31.97	50 50	1.06297 1.06309	1.06303	1.05637 1.05639	1.05638	− .00044
50 50	31.97 31.97	100 100	1.09843 1.09843	1.09843	1.09060 1.09060	1.09060	− .00052
50 50	31.97 31.97	150 150	1.13552 1.13546	1.13549	1.12669 1.12667	1.12668	− .00059
50 50	31.97 31.97	200 200	1.17421 1.17412	1.17416	1.16453 1.16452	1.16452	− .00064
100 100	63.94 63.94	0 0	1.06454 1.06456	1.06455	1.05871 1.05874	1.05872	− .00039
100 100	63.94 63.94	50 50	1.09835 1.09833	1.09834	1.09097 1.09097	1.09097	− .00049
100 100	63.94 63.94	100 100	1.13497 1.13499	1.13498	1.12642 1.12656	1.12649	− .00057
100 100	63.94 63.94	150 150	1.17367 1.17366	1.17356	1.16417 1.16420	1.16418	− .00063
100 100	63.94 63.94	200 200	1.21399 1.21395	1.21397	1.20379 1.20371	1.20375	− .00068
150 150	95.91 95.91	0 0	1.10062 1.10064	1.10063	1.09428 1.09431	1.09430	− .00042
150 150	95.91 95.91	50 50	1.13555 1.13553	1.13554	1.12765 1.12764	1.12764	− .00053
150 150	95.91 95.91	100 100	1.17366 1.17361	1.17364	1.16457 1.16453	1.16455	− .00061
150 150	95.91 95.91	150 150	1.21392 1.21394	1.21393	1.20391 1.20396	1.20394	− .00067
150 150	95.91 95.91	200 200	(c)	....	1.24528 1.24518	1.24523	....
200 200	127.9 127.9	0 0	1.13833 1.13835	1.13834	1.13152 1.13154	1.13153	− .00045
200 200	127.9 127.9	50 50	(d) 1.17485	1.17485	...... 1.16638	1.16638	− .00056
200 200	127.9 127.9	100 100	1.21449 1.21447	1.21448	1.20476 1.20475	1.20476	− .00065
200 200	127.9 127.9	150 150	(c)	.....	1.24579 1.24571	1.24575	

[a] All densities here tabulated are expressed in grams per milliliter.
[b] Change in density per degree rise in temperature.
[c] Solutions of these compositions do not exist at 25° C.
[d] Sample lost by breakage of the container.

The densimeter tube (about 45 cm long and 2.5 cm in diameter) containing the sample is placed in a water bath which is kept in constant circulation. This bath is surrounded by another, also in circulation, the temperature of which is regulated by means of an electric heating coil and a brine cooling coil. The temperature of the inner bath is determined by the use of two mercury thermometers. The large sinker having a length of approximately 33 cm and diameter of 1.3 cm is attached below a small sinker and both are suspended by means of a wire from one arm of a sensitive balance. The small sinker which is in the liquid at all times serves the purpose of keeping the suspension wire taut and in position, and thus the effect of surface tension is eliminated.

Method of Making Observations.—After sufficient time has elapsed for attaining temperature equilibrium at the desired temperature, the first weighing is made with the large sinker attached, and the temperature is immediately read from each of the thermometers. Then the second weighing is made with the large sinker detached from the small sinker. In order to obviate any correction for a possible change in temperature, the first weighing is repeated and the thermometers reread. The average of the temperatures at the two weighings is taken as the true temperature. The difference between the mean of these two weighings and the second weighing is the apparent weight of the large sinker in the sample at the given temperature. After completing the observations at one point, the temperature is changed to the next and the process is repeated in the same order.

RESULTS OF INVESTIGATION.

The results of the density determinations and composition of the samples are shown in Table 1.

In Table 1 the composition of the solutions is expressed in grams of $CuSO_4.5H_2O$ per kilogram of solution. The concentration in grams per liter may be readily obtained by multiplying the above concentrations in grams per kilogram by the corresponding densities. In each case density determinations were made upon duplicate solutions, and these results are seen to agree in most cases to somewhat better than 1 in the fourth decimal place. From the density data for 25° and 40° C, respectively, the thermal density coefficient *a* has been calculated, which may be defined as the change in density (always negative) for an increase in temperature of 1° C.

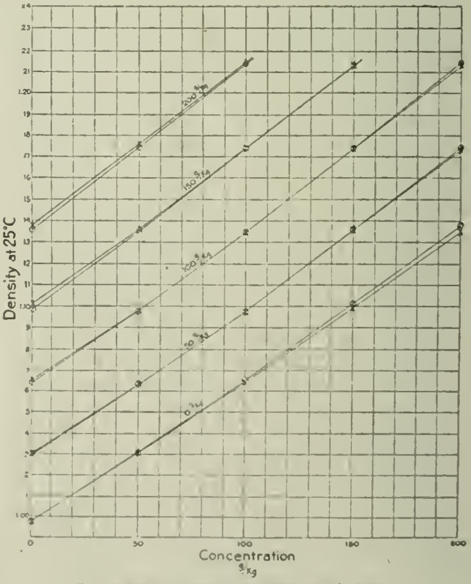


FIG. 1—D[illegible] of copper sulphate-sulphuric acid solutions.
O—Sulphuric acid constant
X—Copper sulphate constant

The above results are shown graphically in Fig. 1, which illustrates the effect upon the density of additions of copper sulphate to sulphuric acid solutions and of sulphuric acid to copper sulphate solutions. The curves for sulphuric acid solutions are derived from the data of Domke as given in Landolt and Börnstein, fourth edition (1912). The close agreement between the densities of solutions of the same total concentration, shown in Table 2, is illustrated in Fig. 1. The curves passing through the circles show the change in density produced by the addition of copper sulphate to solutions containing a definite amount of sulphuric acid per kilogram of solution. Those through the crosses show the change in density produced by the addition of sulphuric acid to solutions containing a definite amount of copper sulphate per kilogram of solution, the total concentration in each case being the same as for the corresponding curve through the circles.

Example.—In the case of the curves marked 50 g/kg, the one passing through the circles shows the change in density produced by the addition of definite amounts (50, 100, 150, 200 grams) of copper sulphate to a solution containing 50 grams of sulphuric acid per kilogram of solution, and the one passing through the crosses shows the change in density produced by the addition of the same definite amounts of sulphuric acid to a solution containing 50 grams of copper sulphate per kilogram of solution.

TABLE 2

Showing the Relation Between Total Concentration and Density

Total concentration, g/kg	$CuSO_4\cdot5H_2O$, g/kg	H_2SO_4, g/kg	Density, 25° C
50	0	50	1.0300
	50	0	1.0302
100	0	100	1.0640
	50	50	1.0630
	100	0	1.0646
150	0	150	1.0994
	50	100	1.0984
	100	50	1.0983
	150	0	1.1006
200	0	200	1.1365
	50	150	1.1355
	100	100	1.1350
	150	50	1.1355
	200	0	1.1383
250	0	250	1.1751
	50	200	1.1742
	100	150	1.1737
	150	100	1.1736
	200	50	1.1749
300	0	300	1.2150
	100	200	1.2140
	150	150	1.2139
	200	100	1.2145

From the above tables and curves it may be seen that—

1. Within the range studied, the density of copper sulphate-sulphuric acid solutions is approximately a linear function of the concentration.

2. The density of solutions of equal (not equivalent) concentrations of copper sulphate ($CuSO_4.5H_2O$) and of sulphuric acid is nearly identical.

3. As a natural consequence of the conclusions noted in (1) and (2), a curious relation was found to exist, i. e., that the density of solutions containing appreciable amounts of each constituent is dependent principally upon the total concentration of the two solutes, and is almost independent of their proportion. (See Table 2.) Thus, a solution containing 50 grams per kilogram of copper sulphate and 150 of sulphuric acid has practically the same density (1.1355) as has a solution containing 100 grams per kilogram of copper sulphate and 100 of sulphuric acid (1.1350). This simple relation which is apparently only a mathematical coincidence, has been used as the basis for the curve shown in Fig 2

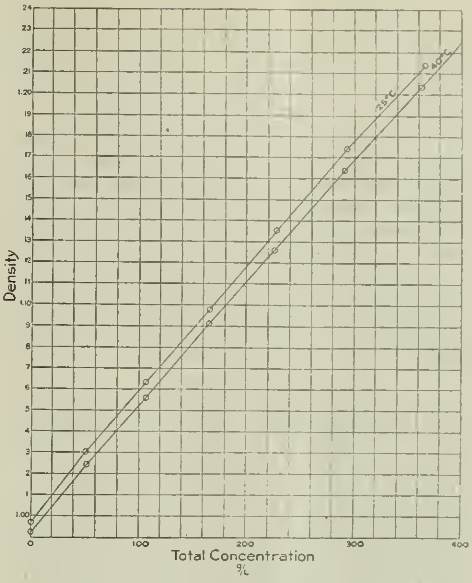


FIG. 2.—*Density of solutions of total concentration of copper sulphate plus sulphuric acid*

TABLE 3

Total Concentration of Solutions of Given Density

25° C		40° C	
Density	$CuSO_4.5H_2O + H_2SO_4$, g/l	Density	$CuSO_4.5H_2O + H_2SO_4$, g/l
1.01	20	1.01	26
1.02	36	1.02	43
1.03	52	1.03	60
1.04	68	1.04	76
1.05	84	1.05	93
1.06	100	1.06	110
1.07	117	1.07	127
1.08	133	1.08	144
1.09	150	1.09	161
1.10	166	1.10	178
1.11	183	1.11	195
1.12	200	1.12	212
1.13	217	1.13	229
1.14	234	1.14	247
1.15	251	1.15	265
1.16	268	1.16	282
1.17	286	1.17	300
1.18	303	1.18	318
1.19	321	1.19	336
1.20	339	1.20	354
1.21	357	1.21	372
1.22	375	1.22	390
1.23	393	1.23	408
		1.24	427

in which the total concentration, in grams per liter,[6] of copper sulphate plus sulphuric acid is plotted against the density, yielding an almost straight line. The application of such a curve, or of the table derived from it (Table 3), in determining the composition of unknown solutions, is obvious, involving only a determination of the density and acidity, the latter then being deducted from the total concentration corresponding to the observed density, to obtain the copper sulphate concentration.

Details of the application of this table in the regulation of electrolytic copper baths will be given in the second edition of Bureau of Standards Circular 52.

This work was carried out under the direction of Messrs. W. Blum and H. W. Bearce.

"Cost Accounting for Oil Producers."

The Bureau of Mines, Department of the Interior, has recently issued Bulletin No. 158 on "Cost Accounting for Oil Producers," by Clarence G. Smith. This is the first treatise of its kind and is a simple explanation of the methods that may be employed in cost accounting for oil producers, who, on account of the peculiar and unusual conditions affecting oil production, require a much different system of cost accounting than any other class of business men.

When the principles of accountancy are applied to any business the accounts and bookkeeping methods employed naturally depend on the character of the business, and even though several businesses may be similar in character, the accounting may be varied to suit the conditions peculiar to each when the problems encountered are not uniform. Therefore, in order to plan and carry out the accounts and bookkeeping system best adapted to a particular business, the accountant must study not only local problems, but also the details of the business at large.

Mr. Smith says in part:

"Prior to the actual development of an oil property it is difficult to determine the quantity of oil under the property and the rate at which this oil can be brought to the surface-factors that determine the ultimate value of the property. Consequently there has been much confusion in devising accounting systems that, during the entire life of a property, will show costs and profits from which the producer can determine whether his property is being worked at a profit or otherwise. The Bureau of Mines publishes this report in recognition of a distinct need for a simple treatise on accounting methods adapted to the peculiarities of the petroleum industry.

"Probably many companies operating oil wells are not fully acquainted with details important to the welfare of their business, because their account books fail to furnish them with exact and adequate data.

"With the accountant rests the responsibility of providing the management with reports setting forth the details of the business expressed in fitting terms as well as in dollars and cents. These reports are a means whereby efficiency may be maintained, waste prevented, oil obtained and sold, and money suitably reinvested. They also enable a concern to study the progress of its business in order to conserve to the utmost hte possible benefits from an exhaustible deposit of mineral wealth. When managements realize the extent of the waste at their properties more attention will be given to the character of the accountancy records."

The treatise gives descriptions and discussions of balance sheets, profit and loss statements and bookkeeping methods peculiarly adapted to the oil business. As far as possible, technical phrases have been omitted in order that those not familiar with accounting terms may be able to follow the subject matter. All the systems of keeping books outlined have been found practical and have been in actual use in some particular oil field. The writer has recognized that local differences in field practices exist and has sought to present accounting methods that provide for such differences.

This publication may be obtained free of charge by application to the Director, Bureau of Mines, Washington, D. C.

Dr. Arthur H. Elliott.

Dr. Arthur H. Elliott, 68 years old, formerly a professor of chemistry at Columbia University and chief of the chemical department of the Consolidated Gas Company, died Feb. 28 of Bright's disease, in the Peekskill Hospital, Peekskill, N. Y. Dr. Elliott was born in London, England, was educated there, and after graduation from the British School of Mines in 1879 came to the United States. He completed his educational course in chemistry at Columbia University in 1881, specializing in gases, which brought him his position later with the Consolidated Gas Company. Dr. Elliott was a member of the Engineers' Club, the University Club, the Chemists' Club and the Fireside Club, of Peekskill, N. Y. He lived at 284 Washington place, Flushing. His widow was the daughter of the late Dr. James Uglow. He also is survived by three daughters.

Chemical Clay Products Co.

The Chemical Clay Products Co., Daisy, Tenn., has been incorporated with a capital of $50,000 by L. E. and B. M. Hood, and G. S. Keeling.

---

[6] Obviously, the above relation exists whether the concentration is expressed in grams per kilogram or grams per liter. The data shown in Fig. 2 and Table 3 have been calculated to grams per liter since the results of the analysis of solutions are usually expresed in that form.

DEFERRED CLASSIFICATION FOR CHEMISTS OF DRAFT AGE

Owing to the disturbance in many essential industries on account of important men being drafted, government instructions have been issued relative to deferred classification for chemists. The letter and blank forms "B" and "C" shown on the following page are self-explanatory.

It should be borne in mind that these applications for exemption should be used only in cases where the employee is absolutely necessary for the practical operation of a plant or factory.

It is not necessary to secure copies of blank forms "B" and "C." Simply make a typewritten copy of the forms as shown. In copying the forms sufficient space should be left under each question to accommodate the answer; therefore a longer sheet should be used than shown in the copy. The answers should be filled in with typewriter, using a different colored ribbon.

Form "B" is for chemists who are in the draft, and *not* in the Army or Naval Service.

Form "C" is for chemists who are at present in the Army or Naval Service.

The forms when filled out should be addressed to "Chief of Chemical Service Section, N. A., New Department of Interior Building, Washington, D. C."

How to Proceed.

Below follows a letter from Lieutenant-Colonel William H. Walker, Chief, Chemical Service Section, National Army, outlining the procedure to be followed in such cases:

Office of the Chief of the Chemical Service Section, N. A.
1106 New Interior Building,
Washington, D. C.

By an order of the Secretary of War, the Adjutant General of the Army has authorized the Chief of the Chemical Service Section of the National Army to initiate such measures as are necessary to secure deferred classification for chemists whose services are essential to war industries. Under the Selective Service Regulations such action is limited to a letter of advice to the Local and District Exemption Boards transmitted through the Adjutant General's office, substantially as follows:

> "The Chemical Service Section of the War Department has investigated the status of your company in connection with the production of war material and considers it important that the efficiency of your organization be maintained. In this connection the services of .... as a technical expert in .... have been investigated and it is believed that his continued employment in war industries would be to the best interests of the Government. You are therefore advised to apply to the local exemption board for deferred classification in his case on the ground that he is a necessary highly specialized technical expert of a necessary industrial enterprise. Such action, of course, should be taken only with Mr.. .... .'s consent. If he prefers to enter the military service, please advise this office of that fact in order that his services may be utilized where most needed."

Under the same order of the Secretary of War the Chief of the Chemical Service Section will initiate action for the return to civil industries of any expert chemist whose service in the industry from which he was taken is of more importance to the Government than are his services in a military capacity. He must certify that the man is considered indispensable in industry or that his services are essential to the prosecution of the war, and that his place cannot be filled by a man or woman not in the Army. Except in the cases of members of the Reserve Corps, the action taken will consist of a recommendation to the Adjutant General of the Army that the man concerned be discharged from the National Army, National Guard or Regular Army, as the case may be, re-enlisted or recommissioned in the proper branch of the Reserve Corps, and placed on the inactive list. In the cases of members of the Reserve Corps the action will consist of a recommendation that the man concerned be placed on the inactive list.

The Secretary of War further directs that upon the transfer to the Enlisted Reserve Corps for this purpose the enlisted man so transferred will be directed to report to the employer who requires his services. The employer in each case will be advised of the man's transfer for the specific purpose intended and will be requested to report to the Department Commander at the end of each month the status of the soldier, and should at any time the soldier separate himself from such employment, the employer will immediately notify the Adjutant General of the Army of such separation and, if practicable, the latest address of the man.

The forms "B" and "C" following indicate the proper method of requesting action—a separate application must be made for each man.

(Signed) WM. H. WALKER,
Lieut. Col., Chief, Chem. Ser. Sect., N. A.

FORMS "B" AND "C."

For the benefit of manufacturers who may desire to use them, these forms, issued by the government, are herewith reproduced. It is not necessary to send for blank copies; typewritten copies of these moy be made and the answers filled in using a typewriter ribbon of a different color. Forms should be addressed as indicated in the foregoing article. Read carefully all instructions as to their proper use.

FORM "B"

Name of Manufacturer..
Address ....
Full name of Chemist.......................... (Age) ....
Address ....
Answers: (To be filled in by manufacturer, *not the chemist*)..........................

Information regarding chemist:

1. Is he willing to receive deferred classification? (Yes) ...... (No) ....
2. Serial No.........Liability No.........Questionnaire Classification—Class........Paragraph........
   Date ...... Title and address of Local Board..
   ....
   Has appeal for reclassification been made? (Yes)...... (No) ......
   Date of appeal ....Result ....
3. Length of time chemist has been with your company..........................
4. Proportion of total hours of the services of the chemist now spent on production* of war materials......
5. Education (above grade of high school)..........................
6. Experience:
   Company: Duration of Employment:
7. Nature of materials in the production* of which said chemist is engaged:
8. Relation of above materials to the war:
9. Statement of the importance of the chemist to the above war work by the officer in charge of the department.

Date........... Signed by...........

FORM "C."

Name of Manufacturer..
Address ....
Full name of Soldier.......................... (Age) ....
Camp address..
Answers: (To be filled in by manufacturer, *not by soldier*)

Information regarding soldier:

1. Is the soldier in the Regular Army, National Army or Reserve Corps?
2. If the soldier is in the Regular Army or National Army does he desire a discharge with re-enlistment in the Reserve Corps (inactive list) in order to reenter your employ?..........................
3. If the soldier is in the Reserve Corps does he desire to be placed upon the inactive list in order to re-enter your employ? ....
4. Length of time soldier was with your company..........................
5. Proportion of total hours of the services of the soldier would be spent on production* of war materials
   ....
6. Education (above grade of high school)
   ....
   ....
7. Experience:
   Company: Duration of Employment:
8. Nature of materials in the production* of which said soldier will be engaged:
9. Relation of above materials to the war:
10. Statement of the importance of the soldier to the above war work by the officer in charge of the department.

Date................ Signed................

---

*Under production is to be included research, development and control work necessary to manufacturing operation.

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors.
Synthetic Medicinals, Flavors and Perfumes. Explosives,
Photographic Developers.

Edited by

THOMAS H. NORTON, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

George H. Bruce, LL.B., Keystone Fibre Products Co., Inc., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hebden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles.

H. Gardner McKerrow, of E. F. Drew & Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

EDITORIAL COMMENT

Industrial Reconstruction

War conditions are rapidly bringing about revolutionary changes in our economic fabric. With a stroke of the pen the country's many railway systems are consolidated into a unit. Fundamental price conditions for leading staples are regulated by centralized authority.

Much that is being done in order to ensure the victory of our arms, will cease when the victory is attained. Unquestionably, however, industrial relations during the coming years, after peace is proclaimed, will be radically modified. This fact has been promptly recognized by Great Britain, as the inevitable result of the experiences of the past three years. A national council for the Study of Industrial Reconstruction has been actively at work collecting ideas and suggestions. and has now embodied them in a report which formulates direct proposals for practical reconstruction.

The whole subject is one of importance to our American chemical industry and especially to the rapidly expanding coal-tar chemical branch. It seems desirable, therefore, to note in some detail the features of the British plans.

Essentially the scheme involves the establishment of a complete new system of trade government comparable to existing systems of local government, with a ministry at the head, controlling numerous trade councils with powers comparable to those of the existing county councils of Great Britain. It recognizes the essential principle that industrial interest should be grouped by trades, and not by localities. The preliminary manifesto of the Council is signed by a highly important and representative body of manufacturers and officers of employers' associations. It invites the workers cordially to join with the management in the self-government of industry, gives them an equal status and responsibility on the controlling body. The promoters of the movement attach importance to the support of the trade press.

The council proposes that British industries shall be developed on the following lines:

1. The mobilization of each industry for common action. 2. A greater degree of co-operation between manufacturers. 3. Co-operation between labor and capital, and the avoidance of industrial strife. 4. A more complete association between scientific institutions and traders. 5. Education better adapted to commercial needs. 6. Each industry to be studied as a whole, and freed from unnecessary internal competition. 7. Every trade to present a united front to foreign competition. 8. Output regarded as a duty by both capital and labor. 9. Encouragement by the Government of the activities of traders, with a minimum of interference.

It will be noticed that emphasis is placed upon an increase of output. During the war, so far, it has been necessary to adopt exceptional measures to secure a maximum output of munitions. It is now felt that such ideals must be kept constantly in view in perfecting future industrial relations.

The Council frankly recognizes that there has been a failure on the part of the Government to fully appreciate the importance of industry and commerce to the national welfare. It therefore makes the following suggestions:

(*a*) That a national organization should be established, which will retain all the sterling qualities of the present individualistic system and add to them the necessary ordered force to ensure greater activity; (*b*) that such an organization will need to provide for the representation of all classes of persons engaged in a given industry; (*c*) that industry should, therefore, be enfranchised, and every man and woman, employer and employed, given a vocational or trade vote, by means of which this representation would be effectively realized; (*d*) that every citizen should have the right to register with some approved trade association or trade union, and thus an Industrial or Vocational Register properly classified would be produced; (e) that trade councils should be elected in each industry from the trade associations and the trade unions, chosen upon a truly representative basis, able to speak in the names of the whole of their respective industries; (*f*) that all questions arising between the Government and a given trade should be delegated to the council of that trade, which would have power to deal with them; (*g*) that questions of output, education, trade schools, scientific research, export, wages, markets, tariffs, etc., should be settled in each trade by the council of that trade, and national funds, expended upon such matters should be dispensed through the trade councils.

A Government department would be established to promote or encourage trade, and should be assisted by an advisory council of the chairmen of the trade councils. As regards the trade councils, it is proposed that they shall be elected triennially, and consist of three classes of members—members elected by trades associations, members elected by trade unions, and members elected by the council on the nomination of Government departments.

The dominant feature in the scheme of industrial reconstruction is the basis of a vocational franchise. This renders possible the organization of each trade under a trade council in which labor and capital are both represented.

Such a scheme is essentially democratic in its nature. It should contribute enormously to increase the feeling of solidarity in a given industry, and to further the maintenance of amicable relations between employers and employees. In its entirety it would act as a balance wheel upon the general industrial movement, preventing excesses promoting good feeling and ensuring unity of action in a multitude of directions.

It is not difficult to picture the conditions under which our coal-tar chemical industry could expand, harmoniously and symmetrically, were it backed by such an organization. The problems of building up an export trade would be solved with much less of friction and much more of certainty Unnecessary duplication could be avoided in numerous connections. An intelligent and uninterrupted interest on the part of the Government would be assured.

The fundamental ideas worked out and formulated by our British cousins, under the strain of unprecedented conditions, are well worthy of careful study on this side of the ocean, and especially by those devoted to building up our chemical industries.

German Propaganda?

So many attempts to influence public opinion in this country, by suggestions and rumors of a nature to undermine unity of action and patriotic effort during the war, have been disclosed of late that we may well assume anti-American interests to be closely connected with the circulation of reports to the effect that the National Aniline and Chemical Company is controlled by German capital.

So persistent have these statements become in trade circles that the secretary of the company, Mr. W. T. Miller, has issued the following vigorous protest:

"Our attention has been directed to rumors now current to the effect that the National Aniline and Chemical Company, Inc., is under the control of German interests. Such statements, if made, are, in view of existing conditions, obviously so false that they are assumed to be malicious.

"The fact is this company is American owned and under American control, is operated by American chemists, and makes American dyes from American raw materials. It has brought together an aggregation of producing units under exclusively American control adequate to safeguard American consumers from the disastrous conditions forced upon the country at the inception of the war in 1914."

Mr. Miller intimates further that actions in damages may be instigated against persons circulating such reports.

While it is true that leading factors in the organization, the Schoellkopfs of Buffalo, and Dr. W. Beckers of Brooklyn, are of German origin, all who enjoy their acquaintance know that their American sentiments are of the most stalwart kind, and that they are devoted heart and soul to building up a genuinely American dyestuff industry. Interests adverse to the success of this effort are undoubtedly responsible for spreading the rumors in question.

Indanthrene Colors in England.

As an instance of the energetic effort now being made in England to firmly establish the manufacture of important vat dyestuffs, it is interesting to note that one of the minor factors in the industry, the Solway Dyes Company, Carlisle, are now producing, and in some cases have been producing for some time, the following Indanthrene dyes: Yellow G, Blue, Dark Blue, BO, Green B, Brown BB, Red BN, Pink B, and Violet R extra. Alizarin Sapphirol and Cyanine Green are also manufactured by the company, the former since March, 1916.

British Dyes, Ltd., is also rapidly extending its output of vat dyes, sold under the trade name of chloranthrenes, but essentially identical with the older indanthrenes.

In the case of both companies, the output is hampered by difficulty in securing adequate supplies of raw material.

THE EVOLUTION OF ARTIFICIAL COLORS*

The layman who has casually come into contact with synthetic color manufacture concludes instinctively that there must be a great variety of operations involved in an industry that deals with such complex compounds, and yields products whose number runs well into the thousands. The contrary is the case. Elementary materials are few in number, and equally few are the chemical and mechanical operations required to transform them into an almost endless variety of shades and tints.

Five Stages in the Evolution of Colors.

If we analyze the evolution of a synthetic color, the various stages are as follows:

1. Bituminous coal is submitted to destructive distillation.

2. From the volatile products of distillation, coal-tar is condensed and separated, and a few volatile hydrocarbons are recovered from the current of gas by passage through so-called benzol scrubbers.

3. The coal-tar is submitted to fractional distillation. Among nearly two hundred distinct chemical compounds present in the tar, some eighteen are isolated, possessing more or less value in the synthetic production of colors, medicines, explosives, flavors, perfumes and photographic developers. This total output is augmented by additions from the benzol scrubbers. Of the small group of useful constituents, of chief importance in the color industry are benzene, toluene, naphthalene, anthracene and phenol. The rest, including the three isomeric xylenes, pseudocumene, methyl-anthracene, phenanthrene, and the closely allied carbazole among the hydrocarbons, the three isomeric cresols, and the bases acridine, pyridine and quinoline, play minor although useful rôles.

4. The various coal-tar crudes, as these eighteen substances are termed technically, after being carefully purified, undergo complete transformation by treatment with a few chemicals. Through successive operations the chemist produces from them about three hundred so-called intermediates. These, with a few exceptions, are not susceptible of direct use in the arts. They serve simply as stepping stones.

5. One or more intermediates are submitted to a chemical reaction, bringing about combination or material alteration in molecular structure. The resultant product undergoes the necessary mechanical treatment—filtering, drying, etc.—and constitutes then a commercial ware.

We know but little of the exact combined forms in which carbon, hydrogen, oxygen and nitrogen are present in bituminous coal. Limited, also, is our knowledge of what takes place in a coke oven, as, under the influence of a high temperature, scores of different chemical individuals spring into existence. The initial stage is, therefore, one largely if not wholly of a mechanical nature. The same may be said of the second and third stages connected with the collection, separation and purification of the coal-tar crudes. It is in the fourth and fifth stages that the chemist dominates, and mechanical features assume a purely subordinate position.

In the fourth stage, the manufacture of intermediates, we encounter the great mass of perplexing difficulties. The German and Swiss companies engaged in this branch have mastered these difficulties, have coordinated all the multitude of accessory factors, scientific, technical and commercial. Herein lay the secret of their ability so largely to dominate the world's trade in artificial dyes. Through the thorny mazes of this chemical jungle are struggling, at this moment, hundreds of American coal-tar chemists, determined to achieve as complete a grasp of the complicated industry as their professional rivals on the banks of the Rhine.

Chemical Operations of Color Manufacture.

Nitration is perhaps the most frequent of all the operations involved in color manufacture, as well as the fundamental reaction in transforming coal-tar crudes into high explosives. An aromatic compound is subjected to the combined action of nitric and sulfuric acids. The strong affinity of the latter for water comes into play. The hydrogen and oxygen necessary to form water are extracted from the two associated substances. Nitric acid yields OH and the aromatic compound surrenders an atom of hydrogen, whose place is taken by the residue of the nitric acid molecule, NO_2. The extent and nature of the reaction are affected by the factors of time, temperature and proportions. Thus benzene can be transformed, at will, into mono-nitrobenzene or into any one of three dinitrobenzenes.

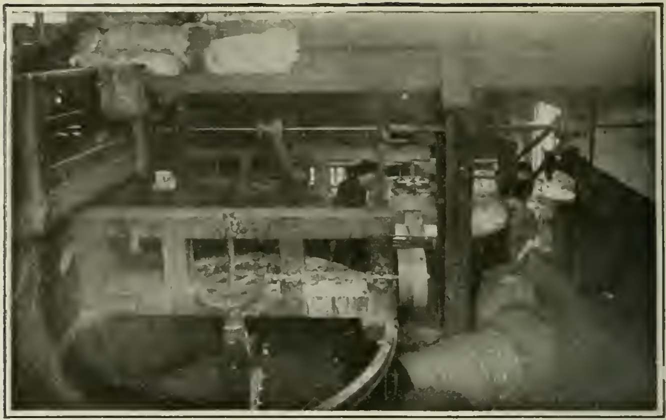
Reduction.—The oxygen in a nitro derivative may be replaced by hydrogen, and the corresponding amido compound thus formed. For example, benzene, C_6H_6 is changed by nitration into nitro-benzene, $C_6H_5NO_2$, and that, in turn, by reduction, into amido-benzene or aniline, $C_6H_5NH_2$. The reaction depends upon the liberation of hydrogen, which in the nascent state easily appropriates the oxygen atoms of the nitro group, introducing in their stead other hydrogen atoms. Iron filings or zinc dust with acetic, hydrochloric or sulfuric acid form the customary reducing agents.

Sulfonation is wholly simliar to nitration, strong sulfuric acid, and very frequently fuming sulfuric acid, being employed in place of nitric. The sulfo group,

---

*From the Scientific American.

DYE MIXING VATS IN OPERATION.



(Courtesy the Scientific American.)

SO_3H, replaces a hydrogen atom in the aromatic compound; thus benzene gives rise to benzene sulfonic acid, $C_6H_5SO_3H$. These derivatives are genuine acids; the hydrogen atom can be replaced by metals, ammonium groups, etc. Thus we have potassium benzene-sulfonate, $C_6H_5SO_3K$. Theoretically, at least, for every nitro derivative of an aromatic compound there is a corresponding sulfo derivative, and many of these are of great importance in the synthesis of valued dyestuffs.

Chlorination.—This term applies to the action of dry chlorine gas upon aromatic compounds. One half of the chlorine employed is recovered in the form of hydrochloric acid, HCl, the other half replaces hydrogen in the aromatic compound. The gas used for this purpose is obtained in connection with the electrolytic production of caustic soda from salt. It is liquified for transportation and allowed to volatilize as needed. The use of bromine and iodine in reactions similar to those of chlorination is limited.

Oxidation is frequently affected by the aid of bichromates, chlorates, permanganates, lead peroxide or managanese dioxide.

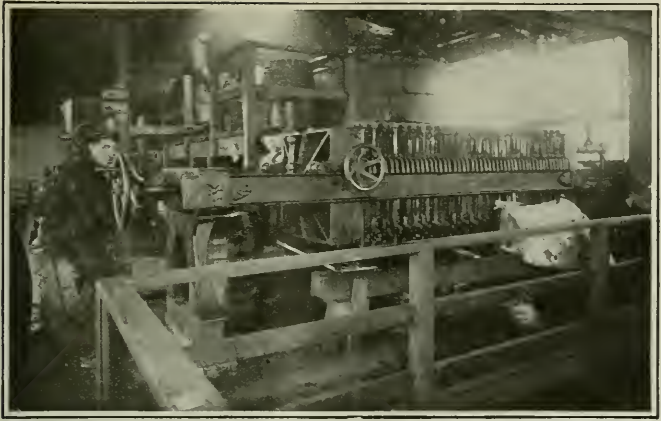
Caustic Fusion is performed chiefly with sulfo acids, occasionally with chloro derivatives. The hydroxyl group, OH, replaces chlorine or the sulfo group. Thus benzene-sulfonic acid, on fusion with caustic soda, yields phenol, or carbolic acid, C_6H_5OH.

Alkylation.—This term is usually applied to the replacement of hydrogen in the hydroxyl or amido groups of aromatic compounds, by the radicals methyl, CH_3, or ethyl, C_2H_5, present in wood alcohol or in grain alcohol. The alcohols or methyl or ethyl chloride are used along with hydrochloric acid, and the operation is effected at elevated temperatures, under pressure. As an example, aniline, $C_6H_5NH_2$, can be transformed into methyl-aniline, $C_6H_5NHCH_3$, or dimethyl-aniline, $C_6H_5N(CH_3)_2$.

Condensation.—This term refers to a large class of operations, in which two molecules of the same substance, or of different substances, unite to form a new compound, with elimination of water, ammonia, or hydrochloric acid. Sulfuric acid, in considerable excess, is the usual condensing agent. The chlorides of aluminum, antimony, phosphorus, sulfur and zinc are occasionally employed for the purpose. The manufacture of the so-called ketone group of colors is a good illustration of condensation on a wholesale scale. Use is made here of the compound known as tetra-methyl-diamido.benzo-phenone, termed Michler's ketone, after the inventor. By condensation with twenty-four different coal-tar intermediates, this yields the same number of widely used artificial colors. Thus from the condensation of the ketone with benzoic acid chrome green is obtained; the reaction with dimethyl-aniline gives methyl-violet, etc.

Diazotizing and Coupling.—The formation of diazo compounds is one of the most important in the whole range of color manufacture. Any primary amine, such as aniline, yields on treatment with nitrous acid, HNO_2, the corresponding diazo derivative. Thus aniline, in the presence of hydrochloric acid, changes into diazo-benzene chloride, $C_6H_5N{:}N\text{-}Cl$. The reaction is simple and quantitative, the most easily controlled of all the reactions of color manufacture. An essential condition of success is to maintain the temperature below 4° C., preferably at zero. The diazo compounds, as a rule, can exist only in a cold solution. In this form they react most readily with a great variety of aromatic substances. The term coupling is applied to this reaction. Thus the diazo-benzene chloride mentioned above, upon gently warming its solution with aniline, yields amido-azo-benzene chloride, $C_6H_5N{:}N\text{-}C_6H_4NH_2\ HCl$, the well known dye aniline yellow. With m-phenylene-diamine, the same compound yields another famous dye, chrysoidine.

Carboxylation.—The introduction of the acid carboxyl group, COOH, into the molecules of phenol and its homologues is effected by the joint action of caustic soda and carbon dioxide. Thus phenol, C_6H_5OH, is



LARGE FILTER PRESS IN OPERATION.

(Courtesy the Scientific American.)

easily transformed into salicylic acid, $C_6H_4.OH.-COOH$.

Liming.—Occasionally the products of sulfonation or chlorination are treated with lime, in order to accomplish the separation of several closely allied compounds by means of the differing solubilities of their calcium salts.

Fusion with Sulfur and Sulfides.—An important class of dyestuffs, the so-called sulfur colors, is prepared by the fusion of various coal-tar intermediates with either sulfur, alkaline, sulfides, or mixtures of the two.

The above constitute all the major chemical operations in use by the manufacturer of artificial colors. We must bear in mind, however, that the possibilities of the coal-tar compounds are from the theoretical standpoint literally numberless. For every synthetic dye which has actually conquered its position in the commercial world, somewhere between a hundred and a thousand tinctorial compounds have been created by the coal-tar chemists, tried, and found wanting. Few of these are chronicled with any fullness of detail.

Mechanical Operations of Color Manufacture.

The visitor to a color factory gazes upon a bewildering maze of closed and open containers, pipes and stills and presses. When subjected to strict classification, however, there are but a few general types.

The operations outlined above are carried out under varying conditions of temperature and pressure. In most cases constant agitation of the contents of a vessel is necessary. This is effected by a series of blades attached to a central axis. Heat is usually communicated by circulation of steam through coils of pipe contained in the vessels in which reactions are under way. Frequently, however, these are jacketed with an outer wall so that steam surrounds the entire bottom and sides.

It is often the case that volatile products or noxious fumes are emitted. Here the vessels are tightly covered, with suitable vents. Occasionally condensers are attached, so that volatile liquids are not lost, but flow back constantly into the chamber where the reaction is taking place. In numerous instances the reaction must go on under high pressure. The heavily constructed vessels provided for this purpose, with agitating mechanisms and steam jackets, are termed autoclaves. Necessary adjuncts are thermometers, pressure gages and safety valves.

Of all the mechanical operations involved, that of filtration is the one which appeals most to the eye. The batteries of modern filter presses, highly perfected in every detail, render it possible to separate precipitates in an incredibly short time, and to wash them free from the last trace of the liquors in which they have been produced. The swiftly whirling centrifugal, of such vast convenience to the sugar manufacturer, also comes frequently into play. Vast drying chambers are, however, in constant requisition to remove every vestige of moisture from finished dyestuffs, before they are packed for shipment.

The Evolution of H-acid.

To illustrate in concrete form the workings of a coal-tar color factory, the sequence of operations in the manufacture of a single intermediate may be outlined. Choice will be made of one with a somewhat formidable chemical name—1.8-amido-naphthol-3.6-disulfonic acid. In commerce and in the color factory it is ordinarily termed H-acid.

The starting point is naphthalene, $C_{10}H_8$, secured, in a crude form, from the carbolic oil fraction of coal-tar distillation by allowing the latter to stand for a few days at as low a temperature as possible. The impure crystals are fused and allowed to recrystallize slowly in large vats. This product is washed with hot caustic soda solution to remove phenols, with strong sulfuric acid to remove bases, and finally with very dilute caustic soda. It is then submitted to heavy hydraulic pressure in bags, or is whizzed in a centrifugal and is ready for most uses. If desired in very pure form it is either distilled again or sublimed.

ONE OF THE STEPS IN THE MANUFACTURE OF H-ACID.

(Courtesy the Scientific American.)

Five successive main steps are required to transform this purified naphthalene into the desired acid.

1. Naphthalene is heated for several hours with concentrated sulfuric acid at 180° C. The product is dissolved in water, freed by filtration from a little dinaphthyl-sulfone formed at the same time, and by addition of common salt, precipitated in the form of sodium salt of b-naphthalene-sulfonic acid, $C_{10}H_7SO_3H$.

2. This is next submitted for a short time to the action of concentrated sulfuric acid at 160°. The main product is naphthalene-2.7-disulfonic acid. A certain amount of the isomeric 2.6-acid is formed at the same time. By liming the two are separated; the calcium salt of the latter is insoluble in water, while that of the former is easy soluble. After filtration the calcium salt is decomposed by sulfuric acid, and naphthalene-2.7-disulfonic acid, $C_{10}H_6(SO_3H)_2$.

3. This acid next undergoes nitration. The product is 1.8-dinitro-naphthalene-3.6-disulfonic acid, $C_{10}H_4(NO_2)_2(SO_3H)_2$.

4. This in turn undergoes reduction yielding 1.8-diamido - naphthalene - 3.6 - disulfonic acid, $C_{10}H_4(NH_2)_2(SO_3H)_2$.

5. Upon treatment with dilute sulfuric acid at 120 one of the amido groups, NH_2, in the last-mentioned acid is replaced by the hydroxyl group. The resultant product, $C_{10}H_4.OH.NH_2.(SO_3H)_2$, is the desired intermediate, H-acid.

The numerals in the above formulae serve to indicate the relative positions in the naphthalene molecule of the substituting groups and thus to distinguish between the various isomers. Theoretically there are 210 possible amido-naphthol-disulfonic acids. A relatively small number of these are actually known.

The pathway from naphthalene to H-acid is evidently tedious and complicated. The coal-tar crude costs today 9 cents per pound; the H-acid is quoted at $2.50.

Colors Evolved from H-acid.

When the color manufacturer, however, once has this helpful intermediate in his possession the way is open for the easy production of a large variety of staple dyes by the successive steps of diazotizing and coupling, as described above. With the help of aniline and p-nitraniline, or sulfanilic acid and a-naphthylamine, or aniline, benzidine and m-phenylene-diamine he can make excellent blacks, the rapid production of which, on a large scale in American works, has been of pronounced assistance in lessening the discomforts of the color shortage during the past year. Using other similar combinations with intermediates of simpler manufacture, and the all-potent diazo reaction, we can produce a great variety of standard blues, violets, greens, mauves, olives, bronzes, blacks and blue-blacks, each possessing its own individuality, each of specific applicability to some of the many phases of the dyer's art. All are dependent for their production upon H-acid and the sequence of chemical and mechanical operations outlined above, as well as upon the series of operations involved in the preparation of two or three less complicated accessory intermediates required at the final step in the evolution of each separate color.

In reviewing this complex of chemical and mechanical activity, and in considering the highly specialized human intelligence needed to control and coordinate the multiple factors, need we wonder at the confidence of those directing the great color works of Germany in asserting that a comprehensive American coal-tar dyestuff industry could never be created? And can we refuse an ample measure of patriotic admiration and generous cooperation to the plucky American chemists who are, today, actually creating that selfsame industry? T. H. Norton.

FINAL STEPS IN THE EVOLUTION OF AN ARTIFICIAL DYE

OPENING A FILTER PRESS AT THE END OF AN OPERATION.

(Courtesy the Scientific American.)

GRINDING COMPLETED DYES INTO POWDER PRIOR TO SHIPMENT.

(Courtesy the Scientific American.)

RECENT STUDIES IN COLOR CHEMISTRY

The most important articles in recent foreign journals bearing on the problems of the color chemist are here grouped together.

Contributions to the Chemistry of Caramel. Part I, Caramelan.

By M. Cunningham and C. Doree, Jour. Chem. Soc., 1917, *111*, 589.

Although caramel has been used industrially, notably for the coloring of foods, very little is known of its composition. In company with other coloring matters derived by simple processes from natural products, it is assumed that it is harmless. This is not necessarily true, however, and any addition to our knowledge of the chemistry of caramel such as the study by M. Cunningham and C. Doree is of especial interest to manufacturers and consumers of food products.

When sucrose is heated to 180-190° three products are formed, caramelan, $C_{12}H_{18}O_9$, caramelen, $C_{36}H_{48}O_{24}$, and caramelin, $C_{24}H_{26}O_{13}$, by processes of dehydration and polymerisation. The first mentioned is the subject of the paper.

The authors considered that a study of the process of formation of caramel in the simpler sugars, apart from its specific interest, might have a bearing on the question of the constitution of cellulose in its relationship to the carbohydrates and especially on the connected problem of the formation of humus, peat and coal. Thus sucrose being the precursor of cellulose in plants, the sequence would become sucrose or cellulose, caramelan, humic acid, humin, and finally carbonization to peat or coal.

The constitutional formula of the cellulose unit group in its relation to this formula for sucrose and possible formulae for caramelan is discussed. A resumé of previous work on caramel compounds, the methods of preparation of the pure compounds, their reactions with metallic salts and the effect of heating to different temperatures upon the character of the solid and volatile products are taken up. This is followed by extensive experimental work on the preparation of caramelan and its esters with acetic, benzoic and nitric acids. The aldehydic or ketonic character of caramelan was shown by its compounds with phenylhydrazin in the presence of acetic and sulfuric acids and also its reaction with semi-carbazide. The action of acids, such as 3% sulfuric, 12% hydrochloric and 40% hydrochloric was used to determine whether hydrolysis produced simpler carbohydrates from caramelan. Careful tests of the liquid and solid products were made and throughout the work the formula of each substance obtained was determined by ultimate analysis. Carmelan was subjected to acetolysis and to the action of oxidizing agents such as nitric acid and bromine water. Conclusions reached may be summarized as follows:

Sucrose, on heating to 170°-180° loses two molecules of water, forming caramelan, $C_{12}H_{18}O_9$ or $C_{24}H_{36}O_{18}$, a tetratomic alcohol, m.p. 136°, characterized by the formation of a tetra-acetate, m.p. 107°, a tetrabenzoate, m.p. 105°, and a tetranitrate which is explosive. The second molecular formula is probably correct.

Compounds of caramelan with phenylhydrazin and semicarbazide indicate the existence of one CO or CHO group for each C_{24} unit, formed with extensive dehydration.

Concentrated non-oxidizing acids cause dehydration to caramelin, while weaker solutions hydrolyze and dehydrate, producing dextrose, methylfurfuraldehyde and humic acid.

On oxidation caramelan yields more complex substances, one carbon atom per each C_{24} unit being removed. Acetaldehyde was recognized among the products. Nitric acid forms characteristic nitro-acids.

Caramelan seems to be the first step in the process of anhydride formation and condensation which leads from simple sugars to such complex substances as cellulose, caramelin and humus.

Cochineal.

C. F. Muttelet, head chemist in the central laboratory for the control of adulteration in foodstuffs, France, reviews briefly in Annales des Falsifications for May-June, No. 103, page 228, the reactions and tests applied by that laboratory for detecting the presence of cochineal carmine or ammoniacal cochineal in foods. The long-used test for cochineal, which depends on the emerald green color given when a small amount of uranium acetate is added to the amyl alcohol extract of an acidified solution of the sample, shows a like color when carmine is present and a violet amethystine shade with ammoniacal cochineal. When such colors are yielded by this test of a food, presence of cochineal in some form may be suspected and further confirmed.

The color is first extracted from the foodstuff by amyl alcohol, the extract evaporated on the steam bath, the residue taken up in water and filtered.

Ammoniacal Cochineal.

In a state of powder ammoniacal cochineal is of a violet-gray color, as a solid it is violet-brown and both dissolve in water with a purplish violet shade. The filtered solution, evaporated to dryness on the water bath, leaves a reddish violet residue which dissolves in concentrated sulfuric acid when a brownish orange color, becoming successively yellow then brown and violet when water is added. The solution becomes violet on addition of ammonia, is but little altered by hydrochloric acid, is completely extracted from acid solution by amyl alcohol giving this solvent a cherry red color and the amyl extract yields, as stated before, a violet-amethyst color with acetate of uranium.

Cochineal Carmine.

The carmine-red solution is filtered then evaporated to dryness on the water-bath, which gives a ponceau-red residue dissolving in concentrated sulfuric acid with a cherry-red shade which the addition of water changes from orange yellow to orange. Ammonia colors the solution reddish-violet, hydrochloric acid causes an orange tint; the amyl alcohol extract of the acid solution is orange red and gives an emerald green color with uranium acetate.

Some ammoniacal cochineals partly revert to cochineal carmine. This follows from the method of manufacture which consists in treating cochineal carmine under determined conditions by ammonia. The carminic acid is transformed into carmin-amid which gives to ammoniacal cochineal its peculiar properties. It may be in some instances that this change is incomplete in which case the product reverts again to carmine. These two coloring matters, when present together in a strongly colored substance, may be characterized in the following manner:

The amyl alcohol extract of the color is added to an excess of powdered carbonate of lime, and after some hours of contact the whole is thrown on a filter. The amyl alcohol passes through practically uncolored, the precipitate is washed on the filter with a little 95% alcohol, which removes only traces of the color, and then cold water is added. This becomes strongly colored a red shade while the residue on the filter is tinted violet gray.

The red aqueous solution is acidified with hydrochloric acid and extracted with amyl alcohol, which takes up all the color with a raspberry red shade and gives with uranium acetate the characteristic amethyst-violet shade due to ammoniacal cochineal.

The calcium lake remaining insoluble on the filter is decomposed by dilute hydrochloric acid, forming an orange liquid which yields all its color to amyl alcohol, the orange-red amyl extract giving the emerald-green color with uranium acetate.

In addition to the reaction with uranium acetate there is one other of equal interest, notably the effect of fixed alkalies, an effect of special importance when ammoniacal cochineal is considered as an amid of carminic acid. Theoretically, the fixed alkali changes the ammoniacal cochineal back again into the original carmine, setting ammonia free. Thus the ammoniacal cochineal can be characterized by two color reactions, the amethyst-violet shade given directly and the emerald-green shown indirectly after treatment with fixed alkali, which transforms it into carminic acid.

The test is as follows: An aqueous solution of ammoniacal cochineal is added to its own volume of caustic soda, 30° Bé. The violet tinted mixture is heated to gentle ebullition under a reflux condenser. Ammonia is disengaged and the liquid little by little becomes of a purple shade. After 30 to 40 minutes heating the transformation is complete, and the cooled liquid is made acid with hydrochloric acid, which changes its color to the coppery-orange of acid solutions of cochineal carmine. Extracted with amyl alcohol the latter becomes orange red and gives the emerald green color with uranium acetate.

In order to be assured that all of the ammoniacal cochineal has been transformed into carmine the amyl alcohol extract may be treated with powdered carbonate of lime, as previously described. All of the color should be rendered insoluble. The gray-violet precipitate, after being washed with 95% alcohol should yield no color to cold water if it contains no ammoniacal cochineal. Decomposed with hydrochloric acid, however, it gives the reactions of the carmine lake of cochineal.

It is of interest to note that carmine, which as a food coloring is essentially an aluminum lake of cochineal, can be decomposed by concentrated hydrochloric acid and carmine acid extracted by amyl alcohol in much greater abundance than is obtained by the foregoing test so that with uranium acetate very strong color reactions are obtained.

Fastness of Dyestuffs—Standards and Processes.

Established by the "Echtheitskommission," Second Report to the Ver. deutsch. Chem., by P. Heermann, Mitt. k. Materialprüf., 1916, *34*, 153; J. S. C. I., 1917, *36*, 590.

Certain standards prescribed in the first report (J. S. C. I., 1914, 248), have been modified and replaced by the following:

1. *Fastness to light* (1a) Fastness of dyed cotton. The sample is exposed together with the dyed standard in a box suspended in the open under glass, one half of the object being covered by paper or cardboard. At the Materialsprüfungsamt two exposures are always made, one under glass and one in the open, subject to all atmospheric influences. Dressed goods are faster to light than undressed. The type standards are: I, 5% Chicago Blue 6B (424) dyed at the boil with two additions of Glaubers salt. II, 0.8% Methylene Blue BG (659) dyed cold to warm with 2% of acetic acid on a 3% tannin and 1.5% antimony salt mordant. III, 1% Indoin Blue on cotton mordanted as in II. IV, 20% Kryogen Violet with 1.5 times its weight of crystallized sodium sulfide, dyed at the boil with the addition of soda-ash and salt. V, 2.5% Benso Light Red 8 BL, dyed as in I. VI, 10% Hydron Blue G 20% G 20% paste (748) dyed at 60° C. with NaOH and 5% hydrosulfite. VII, 8% Sulfur Black T ext., (720) dyed as in IV. VIII, 25% Indanthrene Blue G C paste, dyed with 6.25% hydrosulfite and NaOH.

(1b) *Fastness of dyed wool.* Tests same as for cotton, exposure of piece goods both under glass and in open. Type standards are: I, 3% Indigotin Ia, powd. (877) dyed at the boil with 10% Glaubers salt and tartar. II, 1.5% Ponceau RR (82) dyed same way. III, 2.75% Amaranth (168). IV, 4.5% Azo Acid Red B (64). V, 5% Acid Violet 4RN (Bad) with Glaubers salt and acetic, from 40 C to boil, finished at boil with sulfuric. VI, 2.5% Diamine Fast Red F (343) after-chromed. VII, 4% Anthraquinone Green GXN (864) dyed as in V. VIII, Indigo (874) dyed to a shade equivalent to 2.4% Sulfocyanin GR ext. (257) or 7% Naphthol Green B (4) dyed with 10% Glaubers salt and tartar, beginning at 50° and finishing at boil for 1 hour.

2. *Fastness to kier-boiling of dyed cotton.* Two tests are made. (A) 5 grams of the dyed sample are intermingled with equal wt. bleached cotton and mixture boiled with ten times its wt. of liquor to which has been added 10% caustic soda, 40°Bé., (sp. gr. 1.357) calc. on wt. of material, for 6 hours at constant vol. (B) Treatment is repeated as under A with addition of 1% "Ludigol" on wt. of material. Standards:—I. The shade is distinctly paler after both treatments and the white cotton somewhat stained. III. The shade is appreciably paler after both treatments but the white cotton shows no more than a trace of stain. In the same class are included cases where the shade becomes paler, when treated as under A and the white cotton is stained but when treated by the B process the white cotton is not stained. V. The dyed cotton under both treatments remains entirely unchanged and the white cotton shows no more than the slightest trace of a stain. Types:—I. Normal Paranitraniline Red dyeing, boiled with soap after development. III. Indigo dyeing to the same depth as 3% Diamine Fast Blue FFB, or 10% Indanthrene Yellow G paste (849) boiled with soap after dyeing. V. Normal Turkey Red (Old Red) dyeing.

3. *Fastness to Decatising of Dyed Wool.* Three tests are applied. (A) The sample is rolled up with the usual material on a decatising cylinder in six layers uniformly and firmly, or in the case of small samples a layer of decatising cloth is wound on first, three further layers are wound on and the whole tied up. The material is steamed for ten minutes counting from the time when the steam begins to issue through the cloth, let stand for five minutes and unwound. (B) The prepared cylinder is steamed for five minutes in a closed vessel under one atmosphere pressure (C) It is steamed for ten minutes under 2½ atmospheres pressure The standards are, I Under treatment (A) a fairly strong change in shade. II. Under treatment (A) no change in shade. III. Under treatment (B) fairly strong change in shade. IV. No change. V. Under treatment (C) no change. Types: I. 2% Thioflavine T (642) dyed at 50 C for ¾ hour. II. 2% Sulfocyanine GR ext. (257). III. 2% Sulfocyanine IV. 2% Croceine AZ (255). V 9% Naphthol Black 6B (269) with 10% tartar, beginning at 40 C and finishing at the boil for one hour.

Sensitizers.

According to Hans Waago in the Danish "Amator-Fotografen," January, 1917, issue, the use of a sensitizer such as Erythrosine for carbon tissue or gum paper enables printing to be carried out in poor daylight or strong artificial light in which bichromated tissue, because of insensitiveness to any but blue-violet rays, will not print. Dr. A. A. Meisling, another Danish scientist, has used Auramine and other dyes also, but has worked most with Erythrosine, results with paper sensitized with aniline colors having been shown as early as 1908 before the Royal Danish Scientific Society.

Water solutions of the dye at dilutions of 1:1000 up to 1:10000 are recommended for detailed and rich prints, the greater the concentration of the dyestuff the more the effect being confined to the surface of the coating. Photometer tests show greater sensitiveness with damp than with dry paper. Erythrosine-sensitized papers are not inferior to bichromated ones in sensitiveness and in poor daylight their green sensitiveness makes them faster than the blue-bichromated papers. When dry and protected from light they will keep in good condition for six months or longer Being less sensitive when dry they should be soaked in water for two or three minutes before use.

To prepare the paper the inventor uses ready-prepared Hochheimer pigment paper which is placed face down in a 1:10000 solution of the dye, bubbles are removed with a brush or wad of cotton wool, and the paper is then turned over and the solution poured over the face. Three minutes is required for sensitizing a paper for immediate use and four minutes when the paper is to be kept. After removing from the sensitizing bath allow to drain for a short time, then dry in well ventilated dark room.

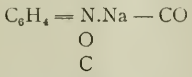
Intravital Staining with Acid Dyes.

W. Schulemann, in the Bichemische Zeitschrift, 1917, *80*, pages 1 to 142, also in Kolloid Zeitschrift, 1917, *20*, page 113 *et seq* discusses the theoretical considerations relative to intravital staining with acid dyes and its significance for anatomy, physiology, pathology and pharmacology. The size of the dye particles affects their ultimate distribution as well as the rate of coloring of an organism. There appears to be no relation between the chemical constitution of a dye and its capacity for intravital staining, the side-chain theory of Ehrlich not being sufficient to explain the action of dyes injected into the living organism. There is, however, a close relation between the rate of diffusion in gelatin gels and intravital staining.

The author considers methods of assimilation and storage of dyes by cells, the relation between amoeboid movement, phagocytic action and capacity for staining, influence of surface, tension and other factors, nature of "granula" and "metachromatism," or differences in colors of dyes in different cells due to amount and character of electrolytes.

Constitution of the Blue Isatin Salts.

The various forms of isomerism in the blue isatin salts and a study of these phenomena by means of the stability of the N and C salts toward water have been described and discussed by M. Claasz in the Berichte, 1917, *50*, page 511. The "internal salt" formula containing Claasz's indigo chromophore



$$\begin{array}{c} C_6H_4 = N.Na - CO \\ O \\ C \end{array}$$

is considered the most plausible.

Color Theories.

Hugo Kauffmann, in an article in the Berichte (1917, *50*, 630) warns against an exaggerated idea of the importance of the degree of unsaturation of a chromophore in connection with color theories. For instance, ethylene and aniline are colorless, while more saturated stilene derivatives, or 1.3.5. trinitrobenzene, are colored yellow or red. The degree of saturation of an ethylene linking is raised by the proximity of a phenyl, carboxyl, carb-ethoxyl or cyano group, but in three cases the color is quite opposite. Unsaturation may confer chromophoric properties on atomic groups but in no sense determines the degree of chromophoric activity.

In a previous article (Ber. 1917, *50*, 515), Kauffmann investigated chromophores with auxochromic functions by a study of the color and fluorescence of compounds of the two types $N.Me_2.C_6H_4.Chr$ and $Chr.C_6H_4.Chr$, and reasons that the brilliant fluorescence shown by these compounds is the result of auxochrome activity of the chromophores in accordance with the rule that a second auxochrome in para position to another yields strongly fluorescent di-derivatives. A tabulation of data on solid compounds is given.

Apparatus for the Color Laboratory.

A convenient form of autoclave or bomb is described by G. W. Morey in the Journal of the Washington Academy of Sciences, (1917, *7*, 205). It is made from 8.7 centimeter pipe, closed by welding on an iron bottom, the upper end also having a cover with an outer rim that presses against an inner shoulder on the outer shell. The outer shell is made of ten centimeter pipe. Closure is made by compression of a gold wire washer and is effected by a bolt threaded through a cross bar fixed to the lower end of the outer shell.

This apparatus may be used with aqueous solutions up to 300°C., and is superior in ease of construction, of manipulation and certainty of closure.

Methyl Red As An Indicator.

In a study of the merits of Methyl Red as an indicator, F. Lehmann and G. Wolff, (Arch. Pharm., 1917, *255*, 113), report that this color is more sensitive to both hydroxyl and hydrogen ions than is Methyl Orange. Oxalic and picric acids can be titrated readily, also alkali borates and cyanides. Sulfites, sulfides and carbonates do not yield sharp end points. This indicator gives standard solutions of practically the same normality as phenol-phthalein, two drops of a one-tenth per cent. solution in one hundred cubic centimeters of a liquid leading to the best results.

Aniline from Ammonia and Benzene.

The formation of aniline from ammonia reacting with benzene at high temperatures in the presence of contact catalysts is the subject of an article in the Berichte, 1917, *50*, 541, by J. P. Wibaut. The author has obtained but a low yield of aniline when benzene and ammonia vapors are passed at 550° to 560°C. through iron tubes containing reduced iron, nickel or copper. The best results followed the use of a stream of ammonia vapor bubbling through liquid benzene at 75°C.

Bixin.

A further study of Bixin, the essential coloring principle of Annatto, by A. Heiduschka and A. Panzer, (Berichte, 1917, *50*, 546) emphasizes the importance of obtaining plant colors in a pure condition. Much depends on the method of isolation and purification, the most reliable specimens in the case of bixin being purified by acetone, then crystalized from ethyl acetate. Molecular weight determinations and analyses of the compound itself as well as its methoxyl derivatives confirm the formula $C_{25}H_{30}O_4$ previously obtained by Herzig and Faltis (Annalen, 1915, *1*, 572.)

An Absolute System of Color Classification.

W. Ostwald, in the Zeitschrift für physicalische Chemie, 1917, *92*, 222, explains his system of classification of colors, the equation involving three terms, $R + W + S = 1$, where R is pure color, W represents white and S black. Colors are tabulated by this system in relation to frequency of vibration, the pure color factor R being determined in terms of the frequency of light in the visible spectrum.

Artificial Color in Alimentary Pastes.

M. P. Balavoine, in the Schweizerische Apotheker Zeitung, 1917, page 141, suggests the following method for determining artificial color in macaroni and other pastes: Twenty grams of the pulverized paste are extracted with 40 cc of ether; the residue dried and again ground is treated with 40 cc of fifty per cent. alcohol. The alcohol is removed by decantation, is filtered or centrifuged, and the extraction is repeated two or three times if necessary. In a 250 cc Erlenmeyer flask 100 cc of water are brought to a boil and the alcoholic extract is added drop by drop, with care, as the liquid foams strongly. This concluded, 5 cc of 10% sulfuric acid are added and the liquid kept at a gentle boil for a quarter of an hour. It may then be used as a dye-bath for coloring a piece of wool

New Coloring Agents for Microscopy, Derived from Methylene Blue.

Messrs. L. Tribondeau and J. Dubreuil have elaborated the method of preparation of Methylene Azure and Methylene Violet. (See abstract in Journ. de Pharm, et de Chim., 1917, *16*, No. 2, page 53) from Methylene Blue.

Egg Color.

Under the title "The Coloring Matter of Egg Yellow, Ovochromin," N. A. Barbieri in Comptes rendus, 1912, *154*, 1726, outlines the method for separation and identification of this color, the recognition of which is of so much importance to food analysts.

Egg yolk is extracted first with carbon disulfide, then with 95% alcohol, until the solvents are no longer colored. They are then separated, the alcoholic portion filtered, evaporated to a paste and redissolved in chloroform. The liquid forms three layers, a watery stratum above, solid white in the middle and chloroform below. Only the water layer contains the egg color, which may be precipitated by acetone and purified by repeated solution in water and precipitation with acetone or dialyzed in aqueous solution. Upon evaporation of the aqueous solution ovochromin appears as a yellow-odorless powder, strongly deliquescent, soluble in an equal weight of water, insoluble in alcohol, ether, chloroform and soluble in fats. It carbonizes at 270° without melting, is weakly acid, gives no biuret reaction and has no albumin or pepton characteristics. It may be declorized by hydrogen peroxide. The ultimate composition is C-42.60% ; H-6.70%, N-8.08% ; S-1.60% ; 0-40.78% Fe- 0.235%. It showed no toxic properties.

Color Tests for Palm Oil.

According to A. H. Gill (J. Ind. Eng. Chem., 1917, *9*, 136), the data obtained on the Crampton-Simons test for palm oil shows conclusively that it is no longer available for testing oleomargarine. The test is unreliable, because of the difficulty in its interpretation, and still more because carotin rather than palm oil is the real cause of the reaction and the test therefore may be obtained with butter, oleo oil, or sesame oil, ingredients ordinarily found in oleomargarine and which cannot be washed out. Further study is in progress.

Color and Chemical Constitution.

Dr. James Moir, in a paper read before the Royal Society of South Africa, describes the color changes produced by substitution in some fifty derivatives of phenolphthalein and fluorescein. The most striking novelty in the paper is the discovery that when these substances are dissolved in concentrated sulfuric acid they give a coloration which is five times as intense as in alkali, and is produced by a band of lower wavelength, the frequency being half as fast again in sulfuric acid after allowing for a constant load due to combination of sulfuric acid with the oxygen of the dye. As, however, fluorescein in alkali and phenolphthalein in sulfuric acid give identical absorption bands, it is suggested that there is in each case a linking up of the phenolic rings.

Cold Facts on a Warm Subject

The Bureau of Mines, Department of the Interior, recently asked the advice of a number of prominent fuel engineers throughout the country as to the best way to conserve in the use of coal during the period of the war. Martin A. Rooney, of Detroit, Mich., had the following to say:

"In every train load of coal laboriously hauled from the mines to our coal bins *one* carload out of *every five* is going *nowhere* and worse. In a train of forty cars the last eight are dead load that might better have been left in the bowels of the earth.

"Every fifth shovel full of coal that the average fireman throws into his furnace serves no more useful purpose than to decorate the ***atmosphere*** with a long black stream of ***precious*** soot. These are not meaningless statistics nor a 'Goblin' story, but ***cold*** *facts* on a warm subject. At best, ***one-fifth of all our*** *coal is wasted.*

"And it is shamelessly and needlessly wasted. Instruments and machinery for getting out all of the heat there is in it are not nearly so complicated nor expensive as the cash register which you use to keep tab on your cash receipts or the truck which you operate to clip a few cents off of your delivery costs.

"Carbon dioxide *temperature and draft* are easier subjects to comprehend than bank discount or freight rates.

"The moral is, Mr. Coal Dealer, get busy and learn what they are and how to use them. The time is coming when the Government is going to limit the amount of our coal that is dumped down your chute and in the name of fairness, when we must deny fuel to some manufacturer, let it be to him who can not show that he is going to use it efficiently. In the name of fairness to the miner who digs it, in fairness to the heavily burdened railroad which transports it, in fairness to a number of our people whose very existence and whose future happiness depend absolutely on the use we make of this most precious of our resources, let us *make efficiency the criterion to judge by* when we come to determine which shall survive.

"And in fairness to the manufacturer who is patriotically operating his properties at nearly to the breaking speed and who is giving up a large part of his profits for the general good let the Government *show him how to conserve* this most important of his raw materials.

"Let us send in to our furnace and boiler room men who can show our engineers and firemen how to burn their fuel with the least waste, as we have sent them among our fields and orchards to show the farmer how to increase the productivity of his soil."

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By Carleton Ellis and A. A. Wells.*

PART XI

Drying of Linseed Oil.

In studying the phenomena of drying linseed oil *Genthe* (Z. angew. Chem. 1906, 2090) made use of the ultra violet light. Uviol lamps made by Schott and Genossen in Jena were employed. The oil was exposed on filter paper to an atmosphere of oxygen in a quartz flask shown in *Fig 1*. A series of these flasks were supported on a special stand, shown in *Fig. 2*, and exposed to the Uviol lamp, during which exposure the absorption of oxygen was measured. Caustic potash was placed in the bottom of the vessel to absorb volatile acid products. No formation of ozone was noted, and in *Fig. 3* curves of oxygen absorption are shown (experiments 79, 80 and 81). During the first two hours the absorption of oxygen was slight. In the third hour the absorption became very rapid, gradually diminishing in rate during subsequent hours of insolation. In *Fig. 4*, curves 73, 74 and 75 are for exposures of linseed oil under same conditions as above except the caustic potash was omitted. Curve 76 is for linseed oil varnish.

To determine whether or not the volatile products of the reaction were capable of exerting a catalytic action, apparatus shown in *Fig. 5* was used. A tube of Uviol glass was filled with fragments of pumice which had been impregnated (in vacuo) with linseed oil. This tube was placed 3 cm from an Uviol lamp. A stream of oxygen was passed first through the tube and then into a Dewar flask maintained at a temperature of −20° C. After 48 hours several grams of a strongly acid liquid had condensed. Some of this liquid was added to linseed oil and the rate of drying was observed. No difference over pure oil was noted.

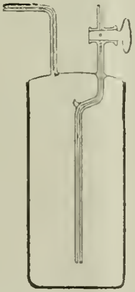


Fig. 1.—Quartz Flask Employed by Genthe for Drying Linseed Oil.

On an average, the oxygen absorption at room temperature was 23 per cent. in the dark and 25.8 per cent. in the ultra violet light. At 95° C. the absorption was 26.5 per cent. and 34.7 per cent., respectively . Beside the main reaction bringing about absorption of oxygen, there is a slow combustion of the organic substance. In light and at higher temperatures this destructive oxidation is considerably augmented. Oxidation is accompanied by polymerization. The weight of the volatile reaction products amounts to 15 per cent.

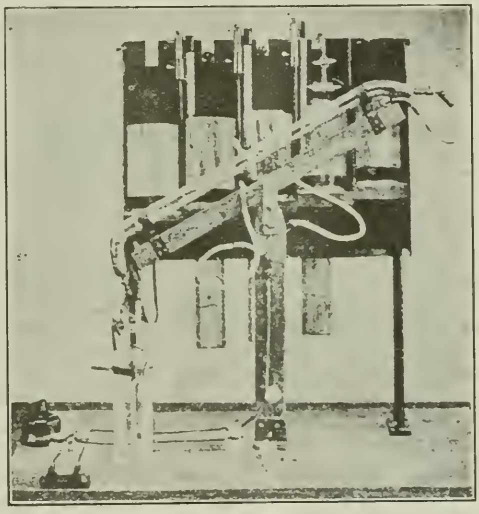


Fig. 2.—Series of Flasks Arranged for Exposure to Ultra Violet Rays.

Other Fatty Oils.

The treatment of vegetable oils by ultra violet light to yield thickened products is described in some detail by *Ellis* (U. S. patents 1,179,414 and 1,180,025, April 18, 1916). Various oils such as linseed, Chinese wood, corn, cottonseed, castor, peanut, fish and whale oils and also resin oils are thickened by exposure to ultra violet radiation. From corn or cottonseed oils, products of the viscosity of castor oil may be prepared and used as castor oil substitutes. An oil which has been exposed in this manner may be subsequently vulcanized with sulphur, when it will be found that less sulphur is required than would be needed to give the original oil the same degree of solidity or elasticity The light-treated oil may be mixed with rubber and vulcanized. In exposing the oil, the fumes which are formed by the action of the light or heat should be removed. This may be done by passing a current of air or other gas over the surface of the oil. The fumes interfere with the free radiation of the ultra violet light and reduce its effectiveness. The oil may be treated in thin layers flowing past the source of light and an inert gas may be caused to flow through the apparatus to exclude oxygen and sweep out the fumes which may be formed. Carbon dioxide is suited for this purpose. From linseed oil a solid product is formed and Chinese wood oil is very quickly solidified to a transparent rubbery material. These light-treated oils may be used in lubricants, varnishes, printing ink and linoleum as well as rubber substitutes.

---

*All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

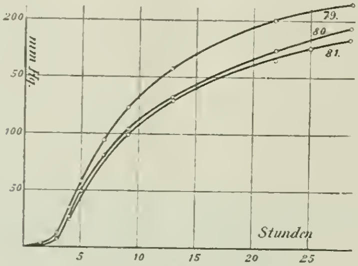


Fig. 3.

Bleaching of Rosin.

A very simple method of bleaching rosin by ultra violet rays is described by *Minor* (U. S. patent 939,733, November 9, 1909). *Fig. 6* shows the apparatus used for the purpose. This consists of a receptacle containing the rosin in a molten state. The receptacle rests on a gas oven used to maintain the requisite temperature. In the walls are placed ultra violet lamps having bulls-eyes through which the rays pass into the rosin. Minor states that the color of the rosin is lightened by this treatment and that the bleaching effect may be varied by longer or shorter exposure to the ultra violet rays.

Polymerizing Action.

A substitute for drying oils as a medium for paints, varnishes and impregnating agents for fabrics, wood, etc., is proposed by *Rohm* (J. S. C. I., 1917, 296 German patent 295,340, June 5, 1915) which consists of a solution of polymerized acrylic acid ester, in acetone, lower fatty esters, or other solvents. The acrylic esters may be prepared from allyl alcohol, glycerin, lactic acid, etc. When exposed to sunlight or artificial ultra violet light, they are transformed into a colorless, transparent, very elastic (not gelatinous) tough mass, which is soluble in the solvents for oils. Alternatively the ester may be mixed with a solvent, and the mixture polymerized. The polymerized ester dries rapidly, resists many chemical agents, and is not readily affected by exposure to weather.

Sterilizing Butter.

A method of improving the keeping qualities of butter has been based upon the sterilizing action of ultra violet rays upon the water used for washing the butter in the dairy. It has been pointed out by *Dornic* and *Daire* (Comptes Rend., 1909, 149, 355) that it avails little to prepare butter from sterilized cream if the water used for washing it contains micro-organisms that tend to produce rancidity. The apparatus employed by Dornic and Daire consists of a tank lined with glass, and provided with glass partitions over which the water passes, and receives the rays from two quartz electric lamps, which are inserted through holes in the cover of the tank. About 3,000 litres of water can thus be rendered practically sterile in a day, the number of bacteria being reduced by the treatment of an insignificant quantity. The cream, or butter itself, might be rendered sterile by this process, but an unpleasant flavor produced by the action of the ozone formed by the lamps prevents the method being successfully employed in practice. A French patent has, however, been taken out (No. 400,921 of 1909) for sterilizing butter or other fats in this way. The substance is spread in a thin layer upon an endless band or revolving drum, the movement of which carries it past a series of lamps emitting ultra violet rays. (Simmons and Mitchell, Edible Fats and Oils, London, 1911, 43.)

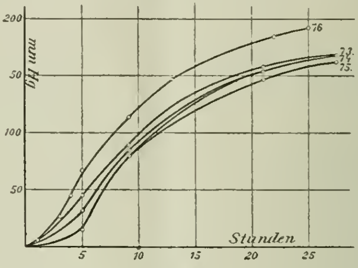


Fig. 4.

In discussing the various methods of sterilizing milk for use in margarine manufacture *Clayton* (J. S. C. I., 1917, 1206) observes that it should be possible to have a large scale ultra violet ray apparatus to sterilize milk at ordinary room temperature, just as Dornac and Daire sterilized water using quartz electric lamps. In any case, the future holds much in store for changing this part of a margarine process involving the incipient reduction of all the bacteria in the milk.

Petroleum Oil.

As previously stated, petroleum oil may be treated by powerful ultra violet rays to destroy its bloom or fluorescence (Ellis, U. S. patent 1,089,359, March 3, 1914). Some oils, by exposure, are reddened in color or otherwise slightly darkened. Other oils are bleached by such treatment. Petroleum oils which are intended to be used as lubricants and which may have gumming properties due to unsaturated constituents, are improved in quality by exposure to ultra violet light. Apparently polymerization occurs, resulting in the formation of saturated bodies. The oil may be exposed in an atmosphere of an inert gas. A high-voltage ultra violet lamp is used advantageously and if the heat which emanates from such lamps is very considerable, the oil may be cooled during the exposure. The treatment may be carried out as a continuous process by causing the oil to flow in a thin layer past the source of ultra violet light.

"Pre-vulcanized" Rubber.

Victor Henri is credited by *Helbronner* with being the first to expose rubber to ultra violet rays, carrying out vulcanization with films made from solutions of rubber, as early as 1909-1910. Rubber solutions which have been vulcanized by means of the ultra violet light, are stated by *Helbronner* (India Rubber World, Dec. 1, 1914, 130) to be insoluble in the same solvent when once they have been dried. This suggests that such solutions would be valuable for making patches on rubber (tires, inner tubes, etc.), for when once the patch had thoroughly dried the result would be the same as though it had been vulcanized. It was also suggested that crystals of sulphur should be used in this work and not flowers of sulphur ,or stick sul- also Compt. rend. 138. 1914, 1343 Chem. Zentr. 1914. 326; Koll. Zeit. 1913, 4; French patent 460,780 July 26, 1913.)

Albumen.

The action of ultra violet light on living cells has been studied by *Bovie,* (Science, 1913, 24), by its effect on certain constituents of protoplasm. Fresh egg albumen when exposed in a quartz tube at 10 cm from a quartz mercury vapor lamp at room temperature, began to show a feathery coagulum in 1 to 2 hours on the wall nearest the lamp, and after 35 hours was quite fully coagulated. The odor was peculiar and quite strong. When dissolved in water the same phenomena was noticed, the time being shortened, possibly due to better penetration. The coagulated material settled to the bottom of the tube. A solution of egg albumen which had been crystallized and not freed from ammonium sulphate coagulated more rapidly than fresh egg white. Solutions of crystallized egg albumen from which the ammonium sulphate had been separated by dialysis was more sensitive, some being coagulated when exposed in glass tubes which cut off the shorter waves. Ox-serum is coagulated when exposed to ulrta violet light in quartz tubes, but not in glass. The coagulated material resembles the material coagulated by heat in that it is insoluble in alcohol, water and dilute acids but is soluble in dilute alkalis.

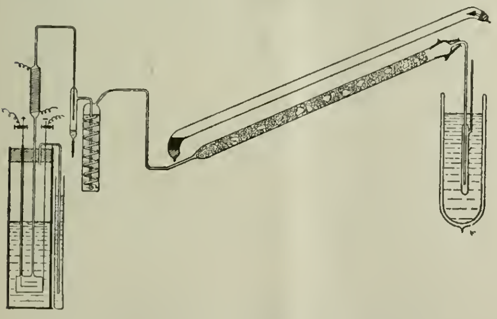


Fig. 5.—Genthe's Apparatus for the Condensation of Volatile Products of Drying Linseed Oil.

The effect of temperature on this coagulation was also studied by Bovie (Science, 1913, 374). When kept at O°C. no coagulation occured in a 5% solution of crystallized egg albumen after 35 hours exposure, but on warming a few degrees coagulation began, and tubes became turbid. If the temperature was again brought to O°C. the tube cleared up, that is the reaction was reversed. This phenomena occurred only when the temperature was reduced as soon as coagulation began. If a clear solution of the albumen which has been exposed to the light for some time at at O°C. is taken from the light and warmed, the coagulation occurs at about the same rate as though it were being exposed. It thus appears that the light produces some substance which causes coagulation but that at O°C. this substance is not capable of bringing about visible coagulation.

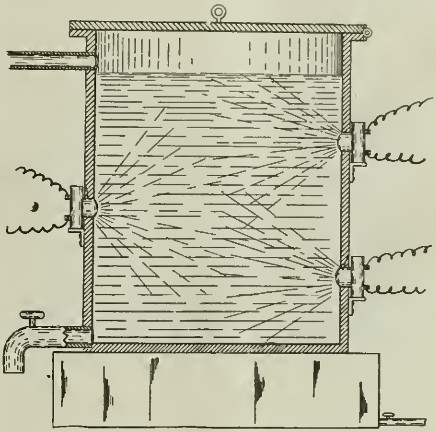


Fig. 6.—Minor's Apparatus for Bleaching Rosin.

Photographic Peculiarities of Alkaloids.

The behavior of a number of alkaloids as regards color when photographed under ultra violet light has been investigated by *Michand* (Science 1912, 415). Twenty-four samples of the powdered alkaloid were placed in boxes and photographed under ordinary light. Only one sample, berberine, showed black, the remainder showing white. Another photograph was taken using a quartz lens silvered on both sides. Berberine still showed black, eight samples showed white or nearly so, three showed gray .and the remainder were black or nearly so. No constant relation was found between this action and the chemical constitution, or of the physical properties, but it appears that the phenomena might be made use of in analytical chemistry.

Phosgene.

Wherly (Color Trade Journal 1918, 8) reports that experiments using ultra violet light for the production of phosgene by the union of carbon dioxide and chlorine have been successfully tried, but that the disadvantages on a commercial scale are manifest. Accordingly he does not believe the major portion of phosgene is manufactured with the assistance of either the actinic rays of the sun or those of ultra violet lamp. Thus it is more reasonable to suppose that by far the greater proportion of phosgene is manufactured by passing carbon monoxide and chlorine over platinized asbestos, charcoal or boneblack heated to redness.

Testing Ink.

Ultra violet light is used for the testing of ink in a rough-and-ready manner. In carrying out this test, streaks of the inks to be tested are placed on a sheet of paper along with a streak made with standard ink. The paper containing the streaks is then exposed to the rays of ultra violet light for varying periods, generally about forty-eight hours, and the relative effect noted. The method is therefore simply a comparison test with standard material (private communication from Percy H. Walker, Bureau of Standards).

Some Physiological Effects of Ultra Violet Rays.

It is commonly known that visible light is a sensation produced in our eyes by vibrations or waves in the ether of space. These waves are so exceedingly minute that their length from crest to crest is generally expressed in "Angstrom Units," each unit being one ten-millionth part of a millimeter.

Ether waves that measure 7600 to 6500 A.u. from crest to crest are manifested to the eye as red light, and those that measure 4200 to 3900 A.u. are seen as violet light. Between these extreme limits of wave-lengths we find visible light of all the colors in the rainbow, the blending together of which in daylight produces what is known as white light, being thus named because it shows all obpects in their true colors. Light that is artifically produced by flame or incandescence usually contains a preponderance of red and yellow rays, so that it does not show colors as correctly as does daylight.

Just as there are no sharp lines of definition between the different colored bands in the rainbow, so also do visible and invisible radiations gradually merge one into the other; and for convenience it may be roughtly stated that the average human eye perceives visible light between wave-leugths from 7600 to 3900 A.u.

Ether waves that measure more than 7600 A.u. (up to about 3,000,000 A.u.) constitute the infra red or heat rays, and those that measure less than 3900 A.u. (down to about 500 A.u.) are known as ultra violet rays.

We have, therefore, three divisions of radiation under consideration that are manifested respectively as infra red or heat rays, visible light, and ultra violet rays, the first and last being invisible. *Andrews* (General Electric Review, Nov. 1917, 9303) affirms that ultra violet rays are by far the most dangerous of all radiations to the eye, and the more so because they are not only invisible but also because we are unprovided by nature with any organ or sense for detecting them, so we know of them only by their effects. Fortunately the most deleterious of the ultra violet rays, i.e., those rays having a wave-length of about 3400 A.u. and less, are completely absorbed by a moderate thickness of almost any ordinary kind of glass, so that, when their existence is known, their harmful effects on the eye can be easily guarded against.

Precautions in Electric Welding.

The electric arc between carbon and iron, and iron and iron, according to Andrews, is one of the most prolific generators of these harmful rays, and operators on arc welding must necessarily be extremely careful in the employment of protective screens. Indeed, it may be stated that electric welding calls for eye-sight protection against intense heat rays, glare, flickering, and ultra violet rays. Notwithstanding this fact, however, complete immunity from bad effects to the eyes of operators can be assured by the proper use of protective lenses. The masks that are commonly used by operators not only are necessary for the protection of the face and neck from direct dangerous radiations but for the protection of the eyes from reflected ultra violet rays; these rays together with heat rays can be reflected from a surface in the same way as visible light, so that complete protection can only be assured by cutting off all light from the eye excepting that which passes through the lens.

For the same reason arc welding should not be carried on in an open shop or even behind screens closed only at the sides. The reflection of the vivid and flickering flashes from the walls and ceiling may easily affect the eyes of other operators who are not engaged in welding, and are therefore unprovided with any protective device.

The light from mercury-arc lamps is also rich in ultra violet rays, but when these lamps are made of glass the rays are absorbed, thus rendering the light harmless excepting for the glare. When made of clear quartz, however, they should never be used excepting when thoroughly screened by suitable glass shades, or very dangerous eye trouble will be sure to ensue, since clear quartz is transparent to ultra violet rays. Spectacles or eye glasses made with so-called pebble or crystal lenses (i.e., natural clear quartz) therefore afford no protection to the wearer; but the rays cannot pass through the ordinary lenses of plain clear glass.

Further Observations on the Protection of the Eyes.

Glasses for protecting the eyes from injurious radiations by *Coblentz* and *Emerson* (U. S. Bur. Standards, Techn. Paper No. 93, 1917; J. Frank. Inst. 183, 629, 1917). The general characteristics of certain newly developed glasses sometimes used for protecting the eye from radiant energy, are given. Because of the difficulty in reproducing the same color in different melts, no attempt is made to give specific data on the transmission for a given thickness of glass, for in order to be exact it would be necessary to examine samples from each melt. The conclusions drawn are representative of an extensive group of glasses available for protecting the eye from (1) the ultra violet, (2) the visible, and (3) the infra red rays. For protecting the eye from ultra violet light, blacks, amber, green, greenish yellow, and red glasses are efficient. Spectacles made of white glass afford some protection from the extreme ultra violet rays which come from quartz mercury vapor lamps and from electric arcs between iron, copper or carbon. The vapors from these arcs emit but little infra red radiation in comparison with the amount emitted in the visible and in the ultra violet. For shielding the eye from infra red rays, deep black, yellowish green, sage green, gold plated, and plush green glasses are efficient. For working near furnaces of molten iron or glass, if considerable light is needed, a light bluish green or sage-green glass is efficient in obstructing the infra red rays. For working molten quartz, operating oxyacetylene or electric welding apparatus, or other intense sources of light, it is important to, wear the darkest glasses one can use whether black, green (including gold-plated glasses), or yellowish green, in order to obstruct not only the infra red but also the visible and the ultra violet rays.

The efficiency with which the eye is protected from ultra violet rays is discussed by *Bell* (American Academy of Arts and Sciences, 1911, 671), who states that under ordinary conditions chemical tests have shown that no permanent effect is caused by exposing the eye to ultra violet rays. In cases where the exposure is severe, lenses should be provided, but the choice of glass is a matter of taste, ordinary optical glass being almost opaque to ultra violet rays. Of the colored glasses, ordinary commercial amber glass seems to be as effective as special glasses, although in the lightest tints, traces of ultra violet will pass, but if the color is deep enough to materially cut down the visible light these traces will disappear. A number of spectograms are shown illustrating the effectiveness of various glasses.

Steinmetz (Radiation, Light and Illumination) observes that since ordinary transparent glass is opaque to ultra violet rays, persons exposed to such rays should protect themselves by the use of glass either in the form of protecting tubes around the source of light or else by wearing spectacles. Very intense ultra violet radiations, however, pass to a greater or less degree through ordinary thin glass. The thickness of the protecting globes therefore should be regulated. Red glass is considered to be more opaque to ultra violet radiations than other varieties. He states that blood is practically opaque to the rays and on exposure of the body thereto, the rays penetrate but slightly beneath the surface where they are absorbed by the blood. He also observes that complete recovery from ultra violet burn may be extremely slow, taking months or even years for practically complete recovery and in some cases where the burn has been extremely severe some after effects, such as, for example, abnormal sensitivity to radiations of short wave length, may be practically permanent.

Simple Tests for Ultra Violet Rays.

Ultra violet rays produce the effect known as "fluorescence" in certain chemical substances. When these substances are seen by a mixture of visible and ultra violet light, such as that emitted from the iron arc, their apparent color is changed. Thus, soda salicylate in tablet form or in powder changes its color from pure white to a bright blue while it is illuminated by the mixture of rays, unless the visible light is so strong that it overpowers the fluorescent color. A high-tension disruptive discharge of electricity between iron points is an excellent source of ultra violet rays for producing fluorescent effects, because it emits an excess of ultra violet rays as compared with its visible light. A pebble or crystal lens can be readily distinguished from one of plain glass by this light, for if the lens is interposed between the iron spark discharge and a fluorescent substance, such as soda salicylate, the blue color will immediately vanish and the salicylate will assume its natural white: but if the lens is made of quartz, the blue fluorescence will remain unchanged.

Fig. 7.—(A) "Iron Spark" Spectrum. (B, C, D) Same, Photographed Through Various Colored Glasses.

Absorption Effects of Color Screens.

Fig. 7 (according to Andrews, *loc. cit.*) shows the full spectrum of the visible light emitted to a disruptive iron spark discharge and also the absorption effects of various colored glasses when interposed between the spark and the photographic plate on which the spectrum is recorded.

Fluorescent Effects.

Andrews (General Electric Review, April, 1916, 318) gives the following list of a few fluorescent substances, most of which are readily obtainable, and which appear white or nearly so under visible light, but which assume bright colors under the invisible ultra violet rays:

Natural calcite from Franklin Forge, N. J., and other localities	Red
Barium sulphide, all tints of	Orange
Cadmium compounds	Yellow
Willemite, natural and artificial	Green
All salts of salicylic acid, such as soda salicylate, etc.	Blue
Some compounds of calcium	Violet

It is a remarkable fact that, broadly speaking, many substances that are quite transparent to visible light are entirely opaque to ultra violet radiation, while other substances are equally transparent to both. Thus glass, mica, gelatin and celluloid even in very thin sheets are quite opaque to ultra violet rays, but clear rock-crystal or quartz, fluorite and selenite are all about equally transparent to visible light and invisible ultra violet rays.

These curious properties may be readily demonstrated thus:

If ultra violet light is directed on a lump of willemite, the latter will glow with a beautiful green fluorescence. If a thin plate of glass or clear mica is now placed between the source of light and the willemite, the green fluorescence of the latter will instantly vanish, and it will appear in its natural color as seen by daylight or any ordinary artificial light. If now a plate of clear quartz or selenite is substituted for the glass or mica, the willemite will continue to glow with its characteristic green fluorescence. It is thus made evident that the glass and mica are opaque to the ultra violet rays which produce fluorescence, while the quartz and selenite are transparent to them. This experiment may be tried with any fluorescent substance other than willemite with similar results.

Lenses made of rock crystal (clear natural quartz) may be used to concentrate the ultra violet rays from iron spark or other forms of ultra violet light apparatus and thus enhance their fluorescent effect.

Some substances, such as barium or calcium sulphite, continue to glow for a time after the exciting ultra violet rays have been cut off, thus illustrating the phenomenon of *phosphorescence* which is simply a persistence of fluorescence.

Steinmetz, (Radiation, Light and Illumination) in discussing the effect of ultra violet rays upon certain dyes and colors, states that substances such as rhodamine and uranine when exposed to ultra violet rays, viewed through a red glass which cuts off the rays of different wave lengths, show a fluorescence in dilute solutions. Weak solutions of the dyes in water, samples of cloth which had been dyed and varnishes containing these colors all showed red fluorescence. The concentrated solutions and the dry colors show no such phenomena.

Portable Military Sterilizer.

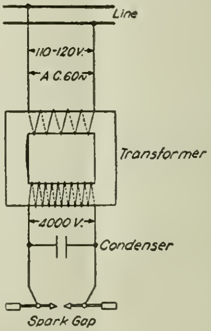
A complete portable ultra violet water-sterlizing apparatus is in use by the Austrian army, (Scientific American, 1917, 515). The plant consists of a small gasoline engine coupled to a rotary pump, and also to a dynamo for generating current fo rthe ultra violet lamp, a sterilizing tank, a rapid filter, hose connections, etc. The apparatus is also fitted with automatic valves so that when once started the machine will need very little attention.

Sterilizing Water Coolers.

A sterilized bottled water service has been established in Chicago by the *Rayvio Water Co.*, (Engineering Record, 1912, 110). The apparatus for sterilizing the water consists of a Cooper Hewitt quartz mercury vapor lamp suspended in a tank 2½ inches above the water. The twice filtered water is passed through the apparatus and bottled, the bottles being sealed with sterilized tin foil, which is punctured by a wire spear which is in the cooler. This delivers sterile water directly into the cooler; which in turn is sterilized every few days by a portable ultra violet light sterilizer.

Municipal Water Purification.

The sterilization of water by the ultra violet ray, including types of apparatus, current consumption and efficiency, is considered by *Rideal* (Water Supply, p. 207; published by Crosby, Lockwood & Son, London, 1914). Arons is stated to have been the first to make use of glowing mercury as a source of light. His apparatus consisted of a glass tube one meter long containing a small amount of mercury. Rideal notes that a number of French cities make use of the ultra violet light to purify their water supplies.



(Courtesy General Electric Co.)

Fig. 9.—Diagram Showing Connections, "Iron Spark" Apparatus.

In discussing the possibilities of municipal water purification by means of ultra violet light, it has been remarked (The Surveyor, London, 1914, 321), that it is somewhat surprising that no more definite information is available regarding efficiency and cost of operation of large installations. Many installations were stated to have been made but no data was available except perhaps as to first cost of installing.

Iron-Spark Apparatus.

The high tension disruptive electric spark between iron terminals is very rich in ultra violet radiation covering about 80 per cent of that part of the spectrum which is useful for producing fluorescent effects. A number of metals other than iron have been used for electrodes, such as zinc, cadmium, magnesium, nickel, cobalt, etc., but, while some of these produce more intense radiation than iron in certain regions of the ultra violet spectrum, they fail to produce any rays of useful power in other regions, whereas iron shows a more uniform distribution throughout the entire range. Iron electrodes have therefore been adopted for use in an outfit recently designed especially for the production of fluorescent effects, described by *Andrews* (General Electric Review, April, 1916, 319.)

This outfit comprises:

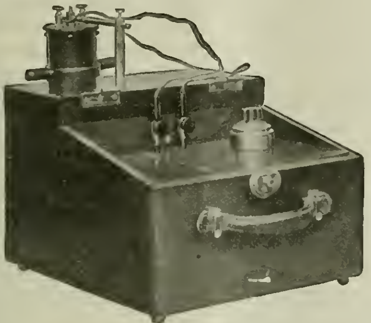
1. A small transformer that steps up 60-cycle, 110-120-volt alternating current to about 4000 volts.

2. A suitable condenser.

3. An adjustable spark gap with removable iron terminals, the whole being protected in a chamber of insulating material.

4. Sundry fittings with connecting cords and plugs.

All of the above parts are fitted into a box for convenient transportation, and it is only a few minutes' work to take out the spark gap, fit it in position and connect the apparatus to any suitable current outlet. As this outfit only uses about 250 to 300 watts it can be safely connected to any alternating current lighting circuit. The iron electrodes are enclosed in a small cylindrical chamber of insulating material, open at one end only, and having the insulated heads of adjusting screws projecting outside, by which the operator is able to regulate the frequency of the spark from 120 per second (with 60-cycle current) up to ten or twenty times that value. This small outfit produces an abundance of ultra violet radiation with which a number of very interesting fluorescent effects may be produced. The rays that are produced by the iron spark as above described naturally contain a large proportion of visible light, and in certain cases, when a substance may show only a weak degree of fluorescence, the color of the latter may be masked or overpowered to some extent by the visible light component.



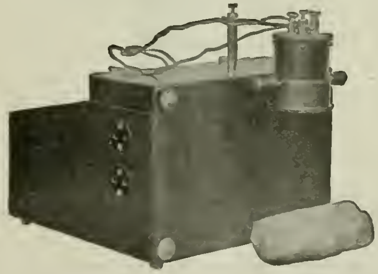
(Courtesy General Electric Co.)

Fig. 9.—Front View, Portable "Iron Spark" Apparatus.

The following simple experiment showing the specific action of ultra violet rays is suggested by the makers of this type of iron spark apparatus: Support a sheet of photographic printing paper, such as "Solio" close under the hood—then turn on the current for a few seconds and the paper will be blackened. To show that it is the invisible ultra violet rays that have produced this blackening, and not the visible light of the discharge, repeat the above experiment, but cover half the exposed circle of solio paper with a sheet of clear thin glass. After exposure it will be seen that the portion of the paper under the glass is unaffected—or very slightly colored, whereas the unprotected half will be blackened. Thin plates of clear quartz or selenite being transparent to the actinic ultra violet rays, the photographic paper will blacken rapidly if plates of these substances are used instead of glass or mica.

Electrode Materials for Ultra Violet Radiation.

A spectroscopic investigation of some sources of ultra violet radiation in relation to treatment by ultra violet rays has been made by *Schunck* (Lancet 1917, 996; Chem. Abs. 1917, 2679) using a quartz spectograph. The sources of radiation examined consisted of metallic electrodes of pure tungsten, molybdenum and iron; one-fourth inch carbon rods impregnated by boiling in solutions of sodium tugstate, uranium nitrate, ammonium molybdate, and titanous chloride; and one-half inch cored carbons filled with pitch blende, haematite, wolfram (75% WO_3, 20% FeO, and 5% MnO) an ore of tungsten, and pure tungsten and molybdenum (99%) in the form of powder, together with Simpson electrodes which are said to consist of wolfram. The most intense and richest source of ultra violet radiations is obtained with tungsten metallic electrodes. The molybdenum spectrum is of a similar character but not so intense throughout, extetnding to U. 2190 but losing in intensity at U. 2300. The iron arc spectrum is very rich in ultra violet radiations but, though containing some dense groups of lines, it is not so uniform throughout as that of tungsten and it extends only to U. 2250. Of the cored carbons, the tungsten powder gives a less intense spectrum than the tungsten electrodes; haematite is almost equal to these electrodes with the advantage of steadiness. The impregnated carbons are much more intense in the spark than in the arc. Uranium nitrate, and ammonium molybdate impregnations give a strong, almost continuous spectrum extending to U. 2300 without much loss of intensity. It seems probable that the radiations of therapeutic value lie between U. 3000 and U. 1850, and an attempt is now being made to determine by spectroscopic means which part of this region has the greatest therapeutic efficiency.



(Courtesy General Electric Co.)

Fig. 10.—Rear View of "Iron Spark" Apparatus.

Magnetic Deflection of the Mercury Arc.

An arrangement by means of which the light of a mercury-vapor arc is obtained free from the effect of absorption is claimed by *Kerschbaum* (U .S. Patent 1,118,868, Nov. 24, 1914). In lightly loaded lamps the illuminating vapor uniformly fills the entire cross-section of the tube between the electrodes, but when there is an increased load, and therefore higher temperature, the radiant vapor retreats from the walls of the surrounding tube, and forms an intensively radiant thread of light located in the axis of the tube, surrounded by comparatively weakly illuminating mercury vapor. The light of the bright radiant axial thread, in order to be able to issue from the lamp, must first penetrate the envelope of vapor and undergo absorption. To obviate this absorption effect, the temperature of the envelope is reduced, and hence the concentration of the absorbing vapor is diminished. This can be effected by cooling outwardly, but owing to condensation of mercury vapor, a coating of mercury forms on the entire inside wall of the lamp and allows almost no light whatever to issue. To prevent condensation of the mercury vapor, the arc is deflected toward one side of the tube of the lamp by means of an electro magnet, thus raising the temperature of the tube at the place where it is applied and burning for itself an aperture in the film resulting from condensation. The light of the deflected radiating arc will issue through this aperture without having penetrated an absorbing layer of mercury vapor. *Fig.* 11 shows the form of construction of this apparatus.

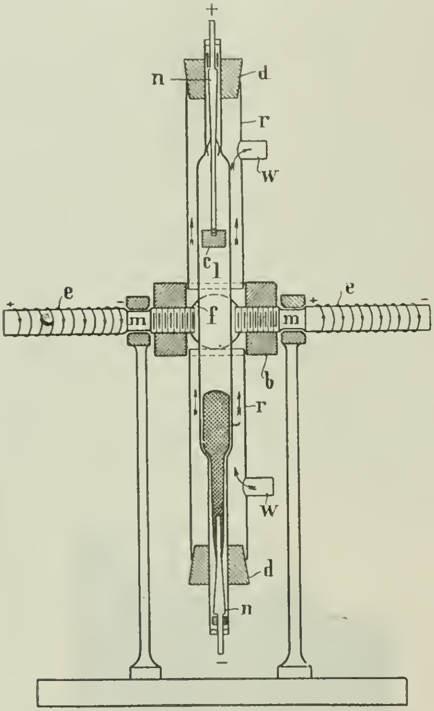


Fig. 11.—Kerschbaum's Apparatus for Magnetic Deflection of Mercury-Vapor Arc.

The brass block (b) has a vertical bore; into this are soldered two tubes (r) having branches (w) for receiving and discharging the cooling water. Into this vertical cooler is inserted a quartz mercury-vapor lamp (l), which is fastened above and below by means of bored rubber stoppers (d). The quartz lamp is a vertically burning lamp, which is of the simplest and most compact construction possible. As leading-in members for the lamp, ground-in nickel-steel pins (n) serve. Only the metal of the lower electrode (cathode) is mercury, the anode is a piece of carbon (c) screwed on the end of the upper nickel-steel pin. The brass block (b) has, in addition, two lateral, horizontal, threaded bores. By means of these apertures the ends of two iron rods (m) are screwed up close to the wall of the lamp; over these rods are pushed coils of wire (e). Each of the two coils has 200 turns of covered copper wire of ½ohm. resistance; the current employed is 2-3 amperes. The electromagnets so formed produce lines of force at right angles to the axis of the lamp. The block (b) has another horizontal bore (f). This passes through only the rear half of the block and can be closed by a quartz plate. When the lamp is burning and the electromagnets are so connected that they deflect the arc to the rear, the light will issue through the bore (f) and enclosing quartz plate. The arc is drawn by rotating the lamp into its horizontal position.

The exposure of many elements to the action of ultra violet light causes them to give off electrons, and the more electro positive the element the more easily will the electron be split off. Alkali metals are most sensitive, yet electro negative oxygen appears to be ionized. To further investigate this subject, *Ludlam*, (Philosophical Magazine, 1912, 757) made experiments on chlorine, the most electro negative element upon which experiments can be made. It was concluded from these experiments that pure chlorine is not appreciably ionized, that traces of chlorine increase the ionization of ordinary air, and that chlorine in considerable quantity reduces the ions and muclei otherwise formed in air.

While investigating the action of ultra violet rays under various conditions *Bichat* (The Electrician, London, 1888, 739) observed that if a conductor connected to an electrometer was exposed to ultra violet rays the electrometer shows a positive potential or in other words the air surrounding the conductor becomes negatively charged.

Temperature-Coefficients for Different Wave Lengths.

The intensity of photochemical action on a mixture of chlorine and hydrogen prepared electrolytically from hydrochloric acid was measured by *Padoa* and *Butironi* (Gazz. Chim. Ital., 1917, 47; J. S. C. I., 1917, 961) who determined the contraction in volume after exposure at definite temperatures in white, ultra violet, and colored light. According to Bevan (Proc. Cambr. Phil. Soc., 12, 398) the temperature coefficient for an interval of 10° C. in the case of a mixture exposed to white light is 1.21. In the determinations of Padoa and Butironi the following coefficients were obtained: In white light, 1.29; green light (nickel sulphate solution screen), 1.50; blue light (copper sulphate screen),

(*Concluded on page* 158)

INORGANIC CHEMICAL SYNONYMS

A Novel Work of Reference for Student and Chemist

By Elton R. Darling*

Although Intended Primarily for the Student, It Is Believed That the Following Compilation of the Various Terms Employed to Designate Inorganic Chemicals Used in the Industries, Will Prove a Convenience to the Experienced Chemist. The Writer Claims No Originality for the Synonyms, but Only the Bibliographical Research of the Material at Hand. Part III Will Appear in the Next Issue.

PART II

Antimony. 120.2

Specific gravity 6.62, fuses at 450° C., melting point 630° C., and has a boiling point of 1440° C. It is trivalent in the antimonious condition and pentavalent in the antimonic.

Its name is derived from the Greek word *anti*, meaning against, and *monine*, the French word for monk. The reason for this was that a number of monks were poisoned by antimony compounds.

No doubt our knowledge of antimony would be much clearer had not the Alexandrean library been destroyed by the Romans. The true discovery of the metal cannot honestly be attributed to any one man.

Antimony is spoken of in the Bible in the book of Hebrews, and again in the second book of Kings. Dioscorides speaks of it as used by the women of his time as an eye-expander. The alchemist Geber was familiar with it. There is little or no doubt that the metal was known long before Valentine's time. Basil Valentine was, however, the first man to give any treatise on the subject. It is believed that his works were the result of a study made of the material scattered throughout the literature of that time. He does, however, credit himself with the discovery of the metal.

Antimony Chloride 226.58
Antimonii Chloridum
Antimonious Chloride
Antimony Trichloride
Terchloride of Antimony
Chloride of Antimony
Caustic Antimony
Muriate of Antimony
Susquichloride of Antimony
Butter of Antimony
Mineral Butter

Antimony Trioxide 288.4
Antimonii Oxidum
Antimony Oxide
Antimonious Oxide
Anhydride of Antimony
Flowers of Antimony
Oxide of Antimony
Teroxide of Antimony
Trioxide of Antimony
Protoxide of Antimony
Hypantimonious Acid
White oxide of Antimony
Antimony Bloom
Valentinite (native)

Antimony Sulfide 336.61
Antimonii Sulfidum
Antimonious Sulfide
Antimony Trisulfide
Tersulfide of Antimony
Sulfide of Antimony
Sulfuret of Antimony
Sesquisulfide of Antimony
Antimony Glance
Antimony Black
Gray Antimony
Crude Antimony
Stibnite Antimonite
Stibnite
Sulfantimonious Anhydride
Antimony Vermillion
Glass of Antimony
Liver of Antimony
Crocus of Antimony

Antimony Pentasulfide 400.75
Antimonii Pentasulfidum
Antimonis Sulfide
Golden Sulfuret of Antimony
Sulfur Auratum
Sulfantimonic Anhydride
Antimony Red
Sulfur Gold

Antimony Potassium Tartrate 332.33
Antimonti et Potassii Tartras
Tartared Antimony
Tartarized Antimony
Tartaric Emetic
Emetic Tartar
Mordant Salts

Arsenic 75.

Specific gravity 5.9. It has a melting point of 850° C., but sublimes at 554° C. without fusing. It is trivalent in the arsenious condition and pentavalent in the arsenic.

Orpimint and realgar were both known to the ancients. Aristotle and Theophrastus both wrote of these products, but made no distinction between them.

The Greek alchemist Olymipiodonis made mention of the white oxide in his writings. Albertus Magnus knew of the properties of arsenic and wrote of its being volatile. He was the first to give any reliable information concerning the element.

Arsenic Oxide 229.92
Arsenic Pentaoxide
Arsenic Acid Anhydride

---

*All rights of publication in book form reserved by the author. Research Textile Chemist, 251 Clifton Place, Brooklyn, N. Y.

  - *Anhydrous Arsenic Acid*
  - *Arsenic Anhydride*
- Arsenic Disulfide 214.06
  - *Arsenic Disulfidum*
  - *Arsenic Bisulfide*
  - *Diarsenious Disulfide*
  - *Realgar*
  - *Red Sulfide of Arsenic*
  - *Red Sulfuret of Arsenic*
- Arsenic Trisulfide 246.13
  - *Arsenious Sulfide*
  - *Yellow Sulfide of Arsenic*
  - *Orpimint*
  - *Sesquisulfide of Arsenic*
  - *Tersulfuret of Arsenic*
  - *Tersulfide of Arsenic*
  - *King's Gold*
  - *Arsenic Yellow*
  - *Sulfo-arsenious Anhydride*
  - *King's Yellow*
  - *Arsenic Orange*
  - *Auripigment*
- Arsenious Oxide 187.92
  - *Arsenici Oxidum*
  - *Arsenious Anhydride*
  - *Arsenic Trioxide*
  - *Acidum Arsenosum*
  - *Arsenious Acid*
  - *Arsenicum Album*
  - *White Arsenic*
  - *Arsenic*
  - *Poison Flour*
  - *Flowers of Arsenic*
  - *Anhydrous Arsenious Acid*
  - *Anhydrous Arsenicosum*
  - *Metallum Album*
  - *Arseni Trioxidum*
  - *Arsenic Blanc*
  - *Arsenolite (native)*
- Arsenic Chloride 181.34
  - *Arseni Chloridum*
  - *Trichloride of Arsenic*
  - *Chloride of Arsenic*
  - *Terchloride of Arsenic*
  - *Sesquichloride of Arsenic*
  - *Muriate of Arsenic*
  - *Butter of Arsenic*
  - *Fuming Liquid of Arsenic*

Barium 137.37.

Specific gravity, 3.78; fuses below red heat, melting at 850° C. and boiling at 950° C. It is divalent.

Barium first became known through one of its compounds, heavy spar. A Bolognese shoemaker, V. Cascionolus, in 1602, noticed that when this product was heated with barbonaceous matter it became phosforesent. To this was given the name lopis solis, Bolognian phosforous, and Boronian phosforous. Marggraf in 1750 supplied the knowledge that it contained sulfuric acid.

In 1774 Scheele, during some researches on the black oxide of manganese, found it to contain a new earth. This product with sulfuric acid formed a compound which was insoluble in water. He did not carry out any further work on it. Gahn in 1776 showed that it was the same compound found in heavy spar.

Guyton de Moroeau in 1779 gave it the name of barote, which was changed to baryta by Lavoisier. The metal was first isolated by Davy.

- Barium Carbonate 197.37
  - *Barii Carbonas*
  - *Carbonate of Baryta*
  - *Baric Carbonate*
  - *Witherite (native)*
- Barium Hydroxide 315.51
  - *Barii Hydroxidum*
  - *Bareum Hydrate*
  - *Milk of Barium*
  - *Hydrate of Baryta*
  - *Caustic Baryta*
- Barium Oxide 153.37
  - *Barii Oxidum*
  - *Barium Monoxide*
  - *Baryta*
  - *Barytes*
  - *Oxide of Barium*
  - *Caustic Baryta*
  - *Baric Oxide*
- Barium Sulfate 233.44
  - *Barii Sulfas*
  - *Blanc Fixe*
  - *Constant White*
  - *Terra Ponderosa*
  - *Sulfate of Barium*
  - *Vitriolate of Barium*
  - *Baric Sulfate*
  - *Permanent White*
  - *Heavy Spar (native)*
  - *Heavy White (native)*
  - *Barite (native)*
- Barium Chromate 253.47
  - *Barii Chromas*
  - *Lemon Chrome*
  - *Ultramarine Yellow*

Bismuth 208.0

In the writing of the alchemists of the thirteenth century mention is made of the word Marcasite, which at that time referred to bismuth. As early as the time of Paracelsus an attempt was made to classify it. He placed it with the semi-metals. Agricola stated that it was a true metal but required the presences of tin. Libavius associated it with antimony, Lemery with zinc and Basil Valentine between tin and lead.

But our true knowledge of the properties and reactions of bismuth was given to us in 1739 by Pott and Bergman.

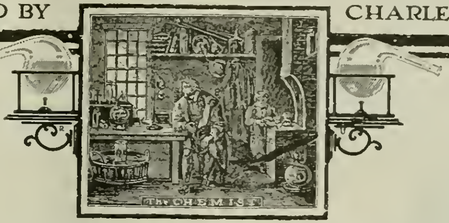
It has a specific gravity of 9.75, fuses at 264° C.; melting point, 270° C., and has a boiling point of 1420° C. In the bismuthous state it is trivalent, and in the bismuthic state it is pentavalent.

- Basic Bismuth Carbonate 526.02
  - *Bismuthi Subcarbonas*
  - *Bismuthi Oxycarbonate*
  - *Bismuth Subcarbonate*
  - *Subcarbonate of Bismuth*
  - *Bismuth Carbonate*
  - *Bismuthyl Carbonate*
  - *Pearl White*
  - *Bismutite (native)*
- Basic Bismuth Chloride 259.46
  - *Bismuthi Oxychloridum*
  - *Bismuthi Oxychloridum*

(*Concluded on page* 158)

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.



ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS.
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

Y. A. N.—It was in the Jingera Mountains, New South Wales, that a rich discovery of bismuth, wolfram and molybdenite was made.

The reefs are from three to five feet wide. A company is being formed to develop these properties.

S. A. A.—The water soluble potash recovered from the 200 blast furnaces is as follows.

	per year. Tons of potash
Flue dust	6.5
Tube dust	180.0
Spent liquor	650.0
Ashes	780.0
Total tons K_2O	1,616.5

Five days after I receive your samples the full report will be rendered.

E. A. W.—Have received the samples of Charcoal, Acetate of Lime, Tar, Wood Alcohol and Crude liquor, also your data as to the quantities you are recovering, and will proceed at once with the investigation.

As requested by you, I will include in my report a sketch of the "chemical plant" as found necessary from the results of my experiments.

I would strongly advise that you reduce your output as agreed, until the completion of this investigation.

W. B. C.—The coal you forwarded me for analysis contains 1% of ash. The melting point of this ash is very low, and since the fusibility of an ash has a very important practical bearing on the use of coal, I would recommend that you immediately notify your dealer to remove it from your premises or deduct the loss in heating value from the bill.

T. W. S.—"Crude Solvent Naphtha," "Solvent Naphtha" and "Heavy Naphtha" are all products of coal tar distillation.

The "Solvent Naphtha" will best suit your purpose.

B. C. K.—From the analysis of the transparent tissue you advised me to obtain in the open market I will state that it is a product of an evaporation of a solution consisting of cellulose esters, with amyl butyrate.

I can supply you with an outline of the necessary equipment for the production of the material.

R. P. D.—As I have mentioned many times in these columns, an analysis is by no means a working formula. On this account you have been subjected to the trouble and expense you mention.

C. C.—A new method for the preparation of Uranium Oxide will be found on page 109 of the May issue of this journal.

This method is covered by two U. S. patents granted to C. L. Parsons, but has been dedicated for the free use of the people, and you can therefore make free use of it. If you experience any difficulty in the manipulation of the process I will be pleased to aid you in every possible way.

G. A. H.—Am pleased to hear that you have overcome your troubles as to reaction, color, mold growth and moisture content.

The samples you are now sending will be reported on as soon as possible.

Charles B. Davis.

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail are specifically requested, communications can only be considered in the order of their receipt.—Editor.

Link's Stationary or Superimposed Water Still

There has recently been placed on the market a further development of the Link Still, the "Link Stationary or Superimposed Water Still," which appears to be the only dependable still for scientifically correct distillation of water. Two illustrations, Figures 1 and 2, show respectively exterior and interior.

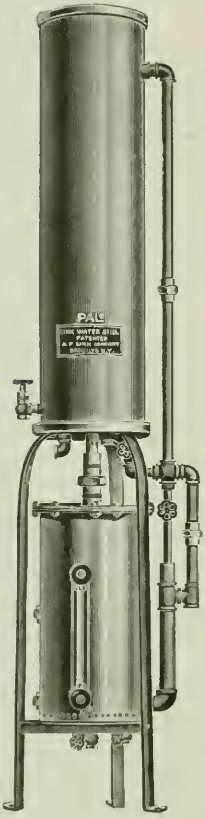


Fig. 1.—Exterior View of the Link Water Still.

The Link still is operated by steam at pressure between 15 and 150 lbs. This is admitted to the coils and has its return outlet at the bottom of the evaporator. The steam inlet and outlet are firmly secured with suitable lock nuts.

The construction of the Link still, in regard to material and workmanship, is of the best. The parts which come into direct contact with the vapors or distilled waters are made of copper and brass, heavily tinned with only pure block tin, the bath dipping process having been employed. This means durability and reliable service. All parts are easily taken apart without dismantling the whole.

The gas vent tubes extending to the top of the condenser act as a reliable gauge for the operator regarding the amount of raw water to be fed to the condenser. Should water vapors escape through these vent tubes, it is proof that the water in the condenser is too hot and more raw water must be fed. Once the flow is regulated no further attention is required.

The Link still is so constructed that the condenser can be taken down or taken apart (for cleaning) without dismantling the evaporator. Likewise the latter may be taken out without interfering with the condenser by simply disconnecting the two union joints, one between the evaporator and condenser and the other on the overflow pipe.

For flushing the condenser as well as the evaporator a valve is provided at bottom of each. This method of flushing entirely prevents scaling and the highest efficiency is maintained all the time. At the bottom of the evaporator there is a separate valve for flushing the sediment cup.

The raw water is fed to the condenser through the valve shown on the left (Fig. 2). The evaporator is constantly supplied with pre-heated water through the overflow pipe. This supply can be regulated by an intermediate valve to keep the water in the evaporator at proper height. All surplus overflow runs to waste.

Chemists have always had unpleasant experiences in analytical, research, material testing, or production to control work, which have in many instances been traced to the use of imperfectly distilled or merely filtered water.

The Link still embodies many innovations, some of which have entirely revolutionized the old time method of distilling water. The novel feaures of the well known and efficient "Link automatic and portable water still" have been embodied in this larger apparatus and have proven entirely successful from every point of view.

The evaporator is at a practical distance below the condenser. The steam coils are enclosed in an annular mantle, which terminates in a sediment receiver, or cup. The latter is provided with a deflector hood and baffle to prevent the sediment or particles of solids from leaving the sediment cup and returning into the boiling water.

This arrangement also keeps the water in rapid circulation in the direction shown by the arrows (Fig. 2). Also soon as boiling commences, the water takes an upward motion, discharging into the cup, where all solid matter (sediment) is gradually gathered and remains below the baffle. The sediment cup can be drained at any time during operation without interfering with the process of distillation.

In other stills it often occurs that particles of solids entrail into the condenser, especially when these stills are worked to full or over-capacity. In the Link still this is prevented by the separator dome near the cover. The vapors, which ordinarily entrail impurities into the condenser, must pass through a series of horizontally located holes in the separator dome and these impurities with the saturated vapors are returned to the boiler. Therefore only dry and pure vapors are permitted to rise through the vapor tube to the condenser. To prevent condensation in this vapor tube an air-insulation space has been provided and the dry vapors reach the condenser sections through the distribution dome. The number of condenser sections varies according to capacity and size of the still.

All the condenser sections terminate into one manifold with one joint outlet for the distilled water at or near the bottom. The outlet is provided with standard size thread for attachment to pipe the distillate away. The outlet is fastened to the bottom with lock nuts and can quickly be detached for occasional cleaning.

Through the onrushing vapors in the vapor tube, the raw water in the condenser near the top becomes quickly heated and passes in this condition through the overflow pipe into the evaporator or to waste. Moreover, as in other stills, a certain amount of ammonia and other noxious gases escape before passing into the overflow pipe. Thus the raw water, partly freed from noxious gases, runs into the evaporator at nearly boiling point, which insures quick and uninterrupted evaporization and effects great economy.

The vapors rising through the moisture separating dome still contain the left-over ammonia and other noxious gases. On their course through the condenser the vapors are pressed against a series of deflectors or baffles. When condensation sets in, the ammonia and other noxious gases are released and escape according to their specific gravity upward through the vent holes, remote from the distillate.

The distilled water flows from the condenser chemically pure and at a temperature as cool as the raw water fed to the condenser. The distillate is therefore immediately available for use. Owing to the large condensing surface, only a small amount of raw water is required as compared with other stills. This results in saving of water and heat.

Another new and important feature in the "Link Still" is the introduction of practical aeration of the distilled water for drinking purposes. This aeration is based on the injector principle. The free air is syphoned through the air intake and in passing between the vapor tube and gas vent neck is rapidly heated and sterilized. It then mixes with the vapors, is absorbed in the process of condensation and is held by the distillate on its downward course during cooling. Through the closing of the air intake a non-aerated, chemically pure distillate is produced.

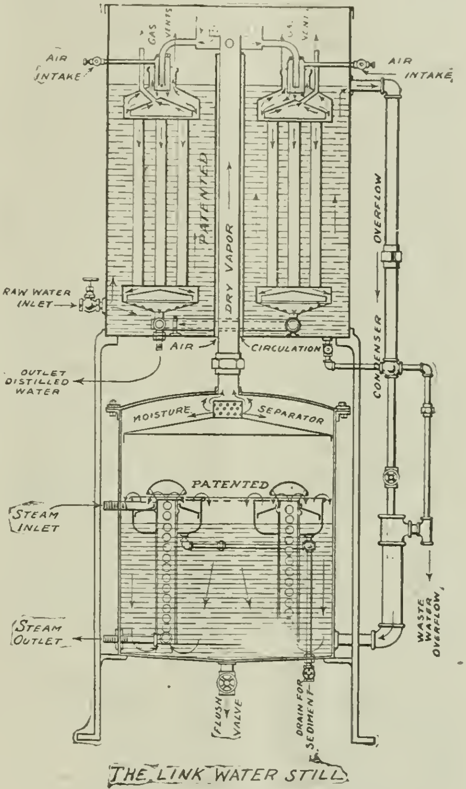


Fig. 2.—Diagram Showing Operation of the Link Still.

The stationary or super-imposed type of "Link Still" is manufactured in various sizes producing 5 gal. to 100 gal. per hour of distilled water.

The floor space required for these stills is comparatively small; the 10 gal. capacity p. h. still requires only 18 inches square.

This patented still has been developed by the A. P. Link Company, and the sole selling rights are in the hands of the Palo Company, 90-94 Maiden Lane, New York City.

West Coast Glass Co.

Glassware of various kinds will be manufactured by the West Coast Glass Co., Inc., Los Angeles, Cal. The capital is $100,000 and the incorporators are H. R. Jones, Frank C. Ford, Arthur White, G. H. Bessemyer and R. D. Tiffany.

An Unusual Design for Distillation and Evaporation.

Those who have to deal with the distilling of sea or other water or with evaporation problems of almost any kind will be interested in this design of Lillie Evaporator, now being built by the Wheeler Condenser & Engineering Co., of Carteret, N. J. It is, as will be noted, a modification of a regular Lillie sextuple effect sea water distilling apparatus. Two of these now under construction are to be operated by steam up to 60 lb. per square inch gauge pressure, or at any lower pressure.

The point that will catch the veteran's eye is the employment of four condensers, side by side, as shown in the illustration.

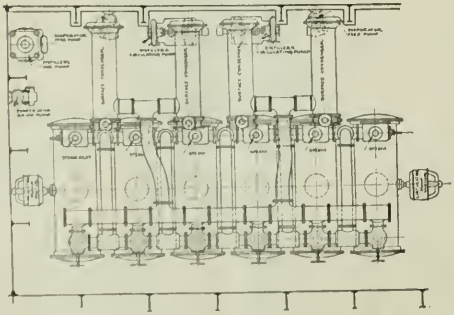
This unusual arrangement of condensers permits seven different combinations of operation, as follows:

(1) It may be operated as one single eeffect or more single effects;

(2) It may be operated as one or more double effects, with vapors reversible in each;

(3) It is possible to operate it as a triple effect, or as two triple effects, with vapors reversible in each;

(4) It is impossible, of course, to operate it as two quadruple effects, but every effect may be utilized by grouping as one quadruple effect and one double effect, in both of which thre vapors are reversible;



The Lillie Evaporator.

(5) It may be operated as one vapor reversible quadruple effect with both end effects or either end pair of the section cut out;

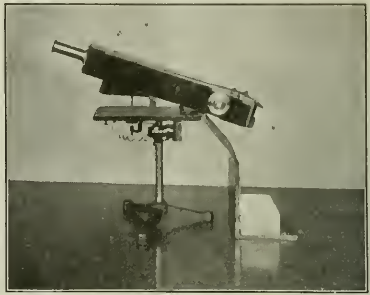
(6) With one effect at either end cut out, it may be operated as a vapor reversible quintuple ffect;

(7) Lastly, it may be operated as a vapor reversible sextuple effect.

It is evident that should a mishap occur at either end, in the middle, or anywhere else, there is little danger that this evaporator will be put out of commission entirely.

The Hess-Ives Tint Photometer.

The instrument illustrated below is used for accurately determining and recording color values by numerical expressions without involving a personal element. The basis of comparison used is thoroughly scientific and not arbitrary. It is applicable to solids or liquids using either transmitted or reflected light. Two magnesium carbonate blocks, the purest white known, are used to furnish the bands of comparison in the two halves of a circular matching field which is similar to that of a polariscope. In order to secure a standard source of light, both day and night as well, in all countries, a "Daylight" lamp of special type has been designed and found to produce uniformity throughout. This enables the operator to check, concordantly, readings taken in laboratories of other countries and regions, which feature alone very much assists the chemist who is required to check up color work obtained in other laboratories.



Hess-Ives Tint Photometer.

The instrument is set in adjustment for use as shown above. The rays of light from the illuminant fall on the magnesia blocks. The light is reflected from these blocks into the body of the photometer through two adjustable slits, one opened and closed by a milled head screw and the other by an actuating lever shown on top of the instrument. In the body of the instrument the light passes through a revolving optical mixing wheel which is made up of a series of lenses and is revolved by means of a small motor. The function of this mixing wheel is to spread the light evenly across the respective half fields which are presented to the eye when looking into the telescope, and which are divided by a vertical hair line. One field is illuminated by the standard white magnesia block and the other by the sample to be tested, which is placed on the right hand block.

The photometric measurements are made through three color-screens, pure red, green, and blue. These screens color both circular fields, but one half-field is darker than the other, due to the effect of the sample. The fields are then brought to the same depth of color by moving the actuating lever over the scale, which closes the aperture illuminated by the magnesia block. When the fields are matched the scale is read off and the expressions recorded.

Special pamphlets fully describing and illustrating this new color instrument have been published by the Palo Company, 90-94 Maiden Lane, New York.

NEW PUBLICATIONS

The Dyestuff Situation in the Textile Industries

The most recent number of the tariff information series of the United States Tariff Commission is a pamphlet on "The Dyestuff Situation in the Textile Industries, 1913 and 1916." In it are presented the results of an inquiry sent to 77 companies who are representative consumers of dyestuffs in the textile industries. Of the companies reporting, 23 were engaged in cotton manufacture, 25 in wool manufacture, 8 in silk manufacture, and 21 were independent dyers and finishers. The cotton manufacturers were the only group reporting the use of smaller quantity of dyestuffs in 1916 than in 1913. A substantial increase as reported by the other groups would seem to indicate that by 1916 the domestic manufacturers of dyestuffs had made considerable progress in replacing foreign-made dyes with those of American manufacture.

The increase in the costs of the individual dyestuffs is particularly striking. In some instances alizarin and anthracene colors were purchased in 1916 at prices 20 to 30 times those paid in 1913. The total value of all the dyestuffs consumed by the 77 companies in 1916 was approximately four times the value of the dyestuffs consumed in 1913. The greatest shortage occured among the dyes which were not made in this country before the war, particularly in the case of synthetic indigo and the vat dyes from anthraquinone needed by the cotton dyer and the alizar in colors needed by the wool manufacturers. Vegetable indigo and natural dyes such as logwood and fustic came into importance as substitutes for the coal-tar derivatives. American-made sulphur colors were given a wide application and certain gallocyanine dyes were developed to replace the imported alizarin and anthracene blue.

The opinions of the textile manufacturers as to the operation of the present dyestuff schedule of the tariff and their suggestions for changes to meet the conditions after the war form what is perhaps the most interesting part of the report. These opinions, which are quoted without the indorsement, criticism, or comment of the Tariff Commission, indicate that on the whole the textile consumers of dyestuffs will give the new American industry the support and patronage that will insure its continuance after the war.

"Comparative Tests of Laboratory Porcelain Ware."

Under the above title a new publication has just been issued by the U. S. Bureau of Standards (Technologic Paper No. 105) which should be of genuine interest to chemists and all laboratory workers. The report, which is in the form of an eight-page pamphlet, was prepared by C. E. Waters, a chemist connected with the Bureau, and recognition is made of the fact that results could not be made as significant as those obtained from tests of glassware. The paper contains a brief outline of the comparative tests of two American, two German, and one Japanese ware; it shows that only the last, and one German make, stood up well when suddenly heated or cooled. Cracks in the glaze formed under the tongs when hot pieces were picked up. At times the dishes broke. The solubilities in various reagents showed that all kinds were about equally resistant. The stains caused by ignition with ferric oxide are superficial and do not depend upon the formation of easily soluble silicates.

The paper is now ready for distribution and those interested may obtain a copy by addressing a request to the Bureau.

New Publications of the U. S. Bureau of Mines.

List 55.—January, 1918.

Bulletins.

Bulletin 130. Blast-furnace breakouts, explosions, and slips, and methods of prevention, by F. H. Willcox. 1917. 280 pp., 2 pls., 37 figs.

Bulletin 152. Abstracts of current decisions on mines and mining, January to April, by J. W. Thompson. 1917. 79 pp.

Bulletin 153. The mining industry in Alaska in the calendar year 1916, by S. S. Smith. 1917. 91 pp.

Bulletin 158. Cost accounting for oil producers, by C. G. Smith. 1917. 123 pp.

Technical Papers.

Technical Paper 174. Suggestions for the safe operation of gasoline engines in mines, by R. H. Kudlich and Edward Higgins. 1917. 199 pp., 3 figs.

Technical Paper 176. Bibliography of recent literature on floatation of ores, July to December, 1916, compiled by D. A. Lyon, O. C. Ralston, F. B. Laney, and R. S. Lewis. 1917. 27 pp.

Technical Paper 180. Firing bituminous coals in large house-heating boilers, by S. B. Flagg, 1917. 22 pp., 1 pl., 16 figs.

List 56.—February, 1918.

Bulletins.

Bulletin 135. Combustion of coal and design of furnaces, by Henry Kreisinger, C. E. Augustine, and F. K. Ovitz. 1917. 144 pp., 1 pl., 45 figs.

Bulletin 139. Control of hookworm infection at the deep gold mines of the Mother Lode, California, by J. G. Cummings and J. W. White. 1917. 53 pp., 1 pl., 5 figs.

Technical Papers.

Technical Paper 98. Effect of low temperature oxidation on the hydrogen in coal and the change of weight of coal in drying, by S. H. Katz and H. C. Porter. 1917. 16 pp., 2 figs.

Technical Paper 133. Directors for sampling coal for shipment or delivery, by G. S. Pope. 1917. 15 pp., 1 pl.

Technical Paper 142. Vapor pressures of various compounds at low temperatures, by G. A. Burrell and I. W. Robertson. 1916. 32 pp., 10 figs.

Technical Paper 158. Compressibility of natural gas and its constituents, with analyses of natural gas from 31 cities in the United States, by G. A. Burrell and I. W. Robertson. 1917. 16 pp., 9 figs.

Technical Paper 199. Five ways of saving fuel in heating houses, by Henry Kreisinger. 1917. 13 pp., 1 fig.

Note.—Only a limited supply of these publications is available for free distribution, and applicants are asked to cooperate in insuring an equitable distribution by selecting publications that are of special interest. Requests for all papers can not be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

New Publications Acknowledged.

"American Lubricants" (From the Standpoint of the Consumer), by L. B. Lockhart, consulting and analytical chemist. 225 pages and index. Illustrations from photographs and drawings. Easton, Pa., The Chemical Publishing Co. London, Williams & Norgate. Tokio, Maruzen Co., Ltd.

"Chemical French," an Introduction to the Study of French Chemical Literature, by Maurice L. Dolt, Ph.D., Professor of Chemistry, North Dakota Agricultural College. 398 pages. Easton, Pa., The Chemical Publishing Co. London, Williams & Norgate. Tokio, Maruzen Co., Ltd.

Pratt Co. Moves New York Office.

Pratt Engineering & Machine Co., manufacturers of equipment for sulphuric acid works, acid pumping apparatus, etc., with main offices and works at Atlanta, Ga., have moved their New York office from 61 Broadway to 25 West 44th street, that city. Joel Hurt is president of the company, George F. Hurt, treasurer, and C. A. Murphy is sales manager of the New York office.

All-State Chemical Mfg. Co.

With a nominal capital of $5,000, the All-State Chemical Manufacturing Co. has been incorporated in New York to engage in the manufacture of chemical and allied products. The incorporators are W. Graveur, D. E. Hubener and F. J. Nice, 525 W. 169th St., New York City

ULTRA VIOLET LIGHT

(*Concluded from page* 150.)

1.31; violet light (methyl violet solution screen), 1.21; and ultra violet light (mercury vapor lamp with nitrosodimethylaniline solution screen), 1.17.

Effect of Ultra Violet Rays on Rainfall.

A theory has been advanced that ultra violet rays form nuclei which causes the variation in rainfall at various localities during the different seasons. *Schultz* (Nature, London, 1912, 68) has made a great many determinations of the ultra violet content of light reaching the earth, and has not been able to find any relation between this content and the rainfall.

(To be continued in the March number.)

INORGANIC CHEMICAL SYNONYMS

(*Concluded from page* 152.)

Bismuthyl Chloride
Oxychloride of Bismuth
Bismouthous Chloride
Cosmetic Bismuth
Basic Bismuth Nitrate 304.03
Bismuthi Oxynitras
Bismuthi Subnitras
Bismuthum Album
Calx Vismuthi
Oxynitrate of Bismuth
Bismuthyl Nitrate
Basic Nitrate of Bismuth
Pearl White
Flake White
Spanish White
Paint White
Bismuth White
Bismuth Trioxide 464
Bismuthi Trioxidum
Bismuthous Oxide
Teroxide of Bismuth
Protoxide of Bismuth
Bismuth Yellow

Strauss & Buegeleisen Move.

Strauss & Buegeleisen, manufacturers and dealers in safety goggles for use in the chemical and allied industries, have entered their new quarters at 438 Broadway, New York.

H. Reeve Angel Co. in New Home.

H. Reeve Angel & Co., distributors for Whatman Filter Papers, have moved their offices and stockrooms from 120 Liberty street to 9 Spruce street, New York, where they will have larger quarters and better marketing facilities.

Atlas Color Works Opens New Plants.

Announcement has been made by the Atlas Color Works, Inc., Brooklyn, N. Y., that the capital stock of the concern has recently been increased from $25,000 to $100,000, due to the expansion of their business. The firm has opened two new plants for the manufacture of indigotin, alizarin and sulphur colors.

FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Cellulose Acetate.

26200—A man in England is in the market for large quantities of cellulose acetate.

Celluloid.

26202—A man in England desires to purchase clear sheets of noninflammable celluloid.

Drugs and Chemicals.

26160—An agency is desired by a company in Peru for the sale of drugs, chemicals, canned goods, provisions, general merchandise, dry goods, etc. Correspondence may be in English. References.

Caustic Soda, Soda Ash, Acetic Acid.

25613.—An agency is desired by a firm in Brazil for the sale of industrial chemicals, caustic soda, soda ash, acetic acid suitable for the textile and soap industries, and all kinds of dyes suitable for cotton textile industry. All business is desired on a commission basis. Cash will be paid. Shipments are preferred through some reputable export house which understands documentation for Brazil, Correspondence may be in English. Reference.

Indigo, Carmine and Coal-Tar Dyes.

25916—An agency is desired by a company in Chosen for the sale of yellow, black, green, pink, and red indigo, carmine, and coal-tar dyes. Goods are desired on consignment, to be paid for or returned within a specified time. Goods should be put up in 1-pound tins, about 100 tins to the case. Correspondence may be in English. Samples and prices should be submitted. References.

Caustic Soda, Tar, Chemicals.

26259—A man in Brazil desires to represent American manufacturers and exporters of wheat, flour, condensed milk, codfish, fresh and preserved fruits, china and enameled ware, household utensils, hardware, iron tools, axes, knives, cutlery, brassware, cement, ship pitch and tar, caustic soda, tin plate, sporting goods, furniture, typewriters, adding machines, all kinds of paper, harmonicas, toys and trinkets, watches, boots and shoes, dressed hides, drugs, chemicals, pharmaceutical products, pneumatic instruments, textiles, hosiery, shirts, and novelties. References.

Fertilizers.

26510.—An agency is desired by a man in Algeria for the sale of agricultural implements, household articles, tinware, binding twine, fertilizers, coffee, tea and canned goods. He also wishes to make direct purchases. Payment will be made by cash against documents in New York or at destination. Correspondence should be in French. Reference.

Bituminous Paints; Waterproofing.

26509.—An official connected with office of the civil commissioner of a city in Mesopotamia is desirous of securing the latest catalogues and price lists of agricultural machinery, graders, ditchers, excavators, machine tools, motor engines, bituminous paints, waterproofing, concrete machinery and material for reinforced concrete.

Orthotoluol Sulphamid.

26114—The representative of a manufacturers' association in South Africa who will be in the United States for a period of three months desires to establish permanent connections with American firms in a position to furnish monthly 3 hundredweight of orthotoluol sulphamid to be used in the manufacture of saccharin. He also wishes to purchase woodworking machinery, foundry equipment, molding machines, envelope machinery, air compressors, marine motors, machinery for producing caustic soda from salt, and machinery for making calcium carbide, also orthotoluol sulphamid. Further information may be had on application to the Bureau or its district offices. References.

Aniline Dyes, Chemicals, Dynamite.

26273—A man in Brazil wishes to buy aniline dyes, chemical products, hardware, cement in barrels, tin sheets in boxes, steel beams, dynamite, barbed wire, smooth wire, steel wire cables, iron bars and plates, copper plates and wire, brass plates and wire, zinc corrugated tiles, linseed oil, zinc white, turpentine, shovels and picks, tar, iron beams, round brass and copper bars, lead and zinc bars, tin rods, potash, steel for springs, steel for making tools, caustic soda, carbonate of soda, chloride of lime, and soda sulphuret. Quotations may be made f. o. b. New York. Payment will be made against documents or by opening credit with local bank. Correspondence may be in English. References.

DISTILLATES

News Notes of Chemical and Allied Industries

Providence Dye Works Burns.

A portion of the plant of the Providence Dye Works, Providence, R. I., was recently destroyed by fire with an estimated loss of $35,000.

Oil Products Plant Burns.

With a loss estimated at $20,000 fire recently destroyed a portion of the plant of the Townsend Oil Products Co., Lima, Ohio.

New Wood Distillation Plant.

At a cost of $700,000 the Kingsport Wood, Reduction Co., will erect a large plant at Kingsport, Tenn., for the manufacture of wood distillates.

To Rebuild Burned Phosphate Plant.

Work will be started immediately by the International Agricultural Corp. to rebuild its phosphate plant at Mt. Pleasant, Tenn., which was recently destroyed with a loss of about $15,000.

New Government Acetone Plant.

A new Government plant will be constructed at Collinwood, Tenn., by the Tennessee Iron & Railroad Co. at a cost of about $800,000. The acetic acid and acetone will be utilized by the Government, while the by-product charcoal will be used for fuel in the iron furnace which the corporation is now building.

Acetone for Aeroplane Wings.

Acetone, which is used to mix with varnish for coating aeroplane wings, will be produced at the new chemical plant which the U. S. Government is planning to erect at Mechanicsville, N. Y. This plant will utilize by-products from the plants of the West Virginia Pulp & Paper Co.

Kalbfleisch to Rebuild Burned Plant.

Operations will be begun at once to replace that portion of the plant of the Kalbfleisch Chemical Co., 3rd Ave. & Baltic St., Elizabeth, N. J., which was recently destroyed by fire.

Will Make Cartridges.

The Burns Cartridge Manufacturing Corp. have been incorporated under the laws of Delaware with a capital of $500,000 to manufacture cartridges, etc.

New Plant for Norcross Chemical Co.

Acids, chemicals and munitions will be manufactured in a new plant to be constructed at once by Norcross Chemical Co., to be located near Stone City, Colo. The buildings will include tank houses, acid towers and boiler rooms.

Merrimac Chemical Co. to Rebuild.

The damaged section of the plant of the Merrimac Chemical Co., Woburn, Mass., which was recently destroyed by fire with an estimated loss of about $10,000, will be immediately rebuilt by the company.

Heller & Merz to Operate in New York.

Authorization papers to operate in New York have been filed by the Heller & Merz Co., Newark, N. J., manufacturers of chemicals, dyes etc. The capital is $500,000 and P. Schnorrenberger, 503 Hudson St., has been appointed New York representative.

To Recover Toluol from Illuminating Gas.

Machinery for the recovery of toluol will be installed by the Springfield Gas Light Co., Springfield, Mass. The company expects in this way to recover about 30,000 gallons annually for government use in producing T. N. T.

New Kelp Reduction Plant.

Plans are being made for the establishment of a large new plant at Oakland, Cal., by the Occidental Chemical Co., which is a reorganization of the kelp reduction interests of the California Chemical Co.

Paints, Varnishes, Etc.

With a capital of $50,000, the Merrimac Veneer Company has been incorporated at Byram, Mississippi, to manufacture paints, varnishes, etc. The incorporators are Frank Morrison, Robert Morrison and Thomas McCase.

Dyestuffs and Allied Products.

The Eureka Aniline Products Corporation, New York, has been incorporated with a capital of $10,000 to manufacture dyestuffs and allied products. The incorporators are H. H. Suhr, H. P. Velte and R. Bennett, 503 West 169th Street.

Heller & Merz Incorporated.

The Heller & Merz Company, Newark, N. J., has recently been incorporated with a capital of $1,500,000 to engage in the manufacture of chemicals, dyes and allied products. The incorporators consist of A. Foshay, A. G. Thanum, and Arthur Williams, all of New York.

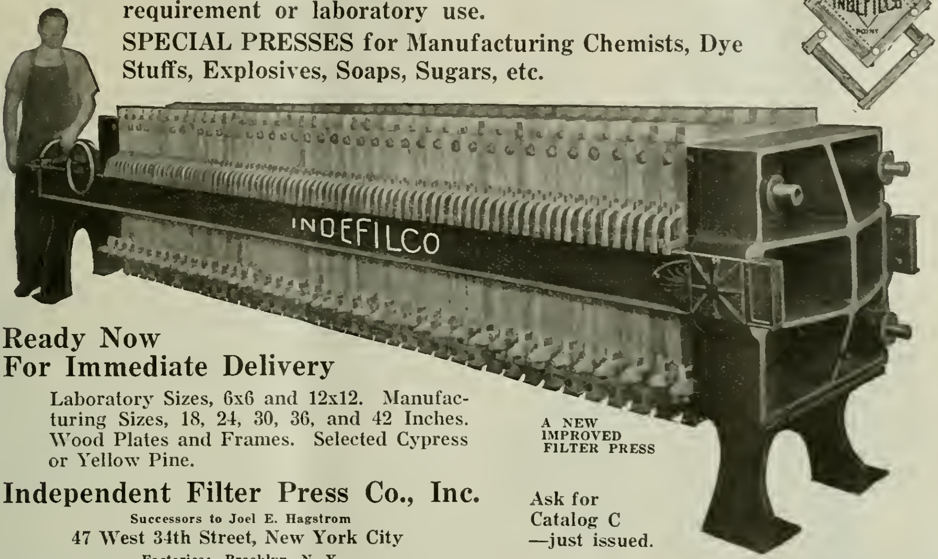
Chemicals and Allied Products.

Blackman & Fink, New York, have been incorporated with capital of $25,000 to engage in the manufacture of chemicals and allied products. The incorporators are M. Fink, and J. and E. Blackman, 66 East 99th Street.

A Press for Every Purpose

We make Filter Presses QUICK for every industrial requirement or laboratory use.

SPECIAL PRESSES for Manufacturing Chemists, Dye Stuffs, Explosives, Soaps, Sugars, etc.



Ready Now
For Immediate Delivery

Laboratory Sizes, 6x6 and 12x12. Manufacturing Sizes, 18, 24, 30, 36, and 42 Inches. Wood Plates and Frames. Selected Cypress or Yellow Pine.

A NEW IMPROVED FILTER PRESS

Independent Filter Press Co., Inc.
Successors to Joel E. Hagstrom
47 West 34th Street, New York City
Factories: Brooklyn, N. Y.

Ask for Catalog C —just issued.

U.S. Acid Proof Paint

SEND FOR SAMPLE ON TIN—READY TO TEST

This paint is proof against the most destructive acids and alkalis, or fumes of the same, in any strength, even to chlorine. It is also proof against steam conditions and dampness.

U. S. ACID PROOF PAINT contains no oil, asphalt, coal tar or pigment. It air dries in about 30 minutes and is permanently flexible. It will adhere to any surface, will not dry out, crumble or peel, and is non-deteriorating even when subjected to the most severe conditions. It is a deep black, will stand dry heat to 350 degrees Fahr. and is highly electrolysis proof.

United States Varnish Company
41 Park Row NEW YORK CITY

GAS
for
Laboratory and Industrial Uses
Automatically and Cheaply Made by the
Detroit Combination Gas Machine
Over 30,000 in Daily Use
The Ideal Plant for Cooking, Lighting, etc., in Homes
Descriptive catalog and names of users in your locality sent on request.
DETROIT HEATING & LIGHTING CO.
616 Wight Street, Detroit, Mich.
Established 1868

BUY *ANOTHER* BOND!

No matter what your part in this war may be, it has been entirely possible for you to own at least three Liberty Bonds by this time.

YOUR DUTY—YOUR PRIVILEGE
Subscribe to the
THIRD LIBERTY LOAN

Our army and navy are the protectors and the only protectors of *your* home—*your* family—*your* income—*your* property.

What will become of you and yours if these protectors are weakened and rendered insufficient to their task?

They will not be defeated by the enemy.

The only way they can be defeated or weakened is through *your* failure to support them with ships, food, weapons, ammunitions, clothing and supplies.

Your life, your business, the future of your family, may depend upon how much real effort and *sacrifice* you make to invest in

Liberty Bonds

In utilizing this advertisement to talk Liberty Bonds rather than our own business, we do so in the firm belief that there will be little of either pleasure or profit in our business or any American business unless Liberty wins this war.

NATIONAL ANILINE & CHEMICAL CO., INC.
NEW YORK CITY

If you would like reproductions of this page singly or in quantities let us know.

THE CHEMICAL ENGINEER

VOL. XXVI. MARCH, 1918 No. 5

Published Monthly by the

McCready Publishing Company.

ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, MARCH, 1918

Page

Enzymes: Their Chemical Composition, Mode of Action, Basic Ingredient and Synthetic Preparation. With Note on "Hemicellutase" 164
Charles B. Davis, F.C.S.

Coal-Tar Chemistry Section 171
Edited by Thomas H. Norton

—German Color Patents 171

—How the Government Views the Growth of American Chemical Industry 174

—Efficiency of American Color Chemists 175

—Profits of European Dyestuff Companies 175

—Artificial Dyestuffs in Italy 177

The Cost of Creating a Merchant Marine 178
John Price Jones

Industry in War Times—"Essentials" and "Non-Essentials" 179
George N. Peek.

Ultra Violet Light: Its Application in Chemical Arts. *Part XII.* 181
Carleton Ellis and A. A. Wells

Inorganic Chemical Synonyms. *Part III.* 189
Elton R. Darling

Analysis of the Chemist—Qualitative and Quantitative 191

New Publications 192

—"Finding and Stopping Waste in Modern Boiler Rooms" 192

—New Publications of the U. S. Bureau of Standards .. 193

Société de Chimie Industrielle 193

The Cost in Coal of Avoidable Belt Slip 194

Foreign Trade Opportunities 197

Distillates 198

Compulsory Syndicates in Germany.

The German Government is developing a pronounced policy in favor of compulsory syndicates of the great industries, more especially in connection with the purchase of materials from other countries. The purpose is to avoid the results of competition, after the war, in securing the necessary raw materials for resuming manufacture on a large scale, and to strengthen individual industries for meeting foreign rivalry in the most effective manner.

No effort has yet been made to force this policy upon the chemical industry, but the matter is under discussion.

At the recent annual meeting in Berlin of the Society for the Protection of the Interests of the Chemical Industry the topic came under discussion. Much opposition was evident to any plan involving State control. It was claimed that the industry demanded the restoration to the fullest extent of freedom in trading, and that the individual corporations should continue, as in the past, to be considered as members of the creative class, able to act independently in their activity for the nation's welfare.

There is evidently much chafing under the manifold restrictions placed upon industrial freedom in Germany during the war, and a desire to prevent any continuance of the policy during peace. The dyestuff industry has already voluntarily consolidated the various factors to such an extent that it can practically act as a unit in selling or purchasing abroad. What it objects to is any material degree of control, on the part of government officials, in formulating and carrying out its plans. There is no opposition to a general supervision of the activity of syndicated industries.

There is no doubt but that the German color industry will leave no stone unturned to recover every possible fraction of its former dominating position in this and nearly every other country. It is abundantly able to carry on its campaign without governmental assistance. The question may, however, be fairly posed, whether it would not be to the advantage of our American color industry, and also of the corresponding industries in Great Britain, France and Japan, if a similar unification of interests should not be adopted by those who will soon be called upon to defend themselves against bold and determined efforts to wreck the results of the past three years.

ENZYMES

Their Chemical Composition, Mode of Action, Basic Ingredient and Synthetic Preparation

with

Note on Hemicellutase

By

CHARLES B. DAVIS, F. C. S.

Modern text books and chemical literature in general inform us that enzymes cannot be produced by chemical means and are of unknown chemical composition. For example:—

Euler-Pope (*General Chemistry of the Enzymes. Page* 7, 1912.)

> "The dynamics of the enzymes suffers in considerable measure from the disadvantage that we know nothing of the composition of these bodies, and hence can form beforehand no idea of the chemical processes taking place during their action."

Cohenheim (*Enzymes.*)

> *Page* 1. "Chemistry cannot produce enzymes."
>
> *Page* 22. "We cannot detect or estimate the enzymes themselves. We can only observe their action."

Sykes. (*Brewing, Page* 109, 1897.)

> "Conclusions as to the nature of diastase are all merely suppositions, with no direct evidences."

Holleman-Walker. (*Organic Chemistry.* 1915, *Page* 286.)

> "The chemical structure of the enzymes is at present wholly unknown. Most of them have not been obtained in the pure state. Their power of decomposing compounds is also not understood. Hitherto, only small insight has been obtained into the conditions upon which their action depends."

Effromt-Prescott. (*Biochemical Catalysto in Life and Industry.* 1917, *Page* 16.)

> "Mechanism of action of enzymes—We may now inquire how enzymes effect these results. It is not easy to answer this question, since the nature of these bodies is unknown."

Similar statements are to be found throughout scientific journals and works on chemistry so it is not unreasonable to say that, previous to the publication of this paper, nothing but the action of these bodies was known.

This paper deals with their synthetic production by chemical means, including their chemical composition, and why they act and how they act on carbohydrates, albumin, sugar, etc. It is also shown why acids, alkalies, metals and certain elevated temperatures cause them to become inactive.

The writer has hesitated for some little time to publish this article on account of the manner in which chemical research is received. The attitude of scientists toward this class of work is not encouraging, to say the least.

Let us take, for instance, the case of E. Buchner, who, in the *Berichte der Deutschen Chemischen Gesellschaft,* No. 30, 1897, pages 117-121, published his preliminary researches on a newly discovered enzyme of fermentation, called by him "Zymase." In the same paper, No. 30 and 31, he published further researches on the same subject.

In the issue No. 31 no less than three chemists denied the existence of such an enzyme and of the phenomena he described.

In the face of all this, the existence of the enzyme is now a proven fact.

It would serve no good purpose to further expand this paper by citing additional instances of premature criticism; the above is sufficiently representative to illustrate the experiences of many. Yet, even at the risk of including matter which does not properly belong in a paper of this sort, the impulse to refer briefly to the writer's own case is strong. It must be kept clearly in mind, however, that honest criticism is resented by no right-thinking individual, no matter what his particular line of endeavor may be. But a certain form of criticism—that which hastily assails results without being in its own turn based upon the results of painstaking, adequate tests—is encountered with lamentable frequency in chemical literature. And if the foregoing homily, and what follows hereafter, should serve to lessen in the slightest degree this most useless of in-door sports it is believed that its intrusion has not been altogether unwarranted.

After the publication of the writer's paper on "A Starch-Forming Enzyme," which appeared in the Journal of Industrial and Engineering Chemistry, February, 1915, several well-known chemists went on record to the effect that they could not confirm the results given, some of their criticisms being:—

1. "Not the slightest indication of the activity of

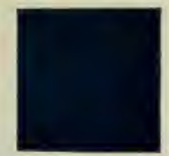


Fig. 1

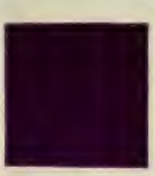


Fig. 2

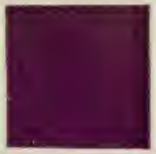


Fig. 3

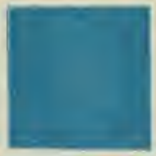


Fig. 4

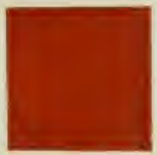


Fig. 5

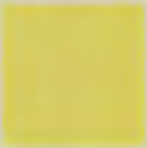


Fig. 6

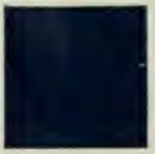


Fig. 7

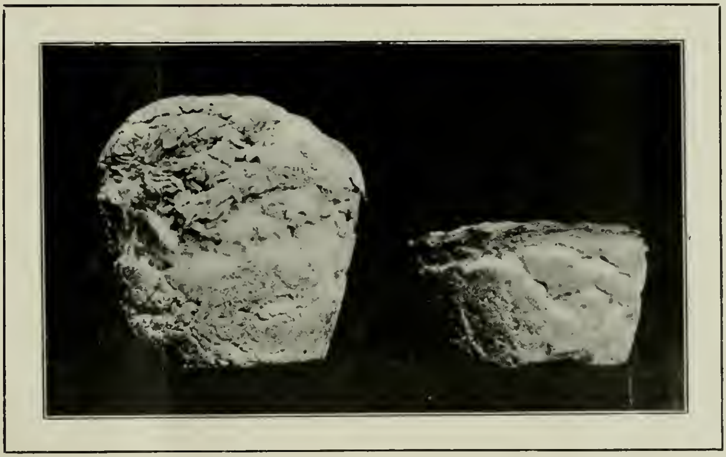


Fig. 10

Fig. 11

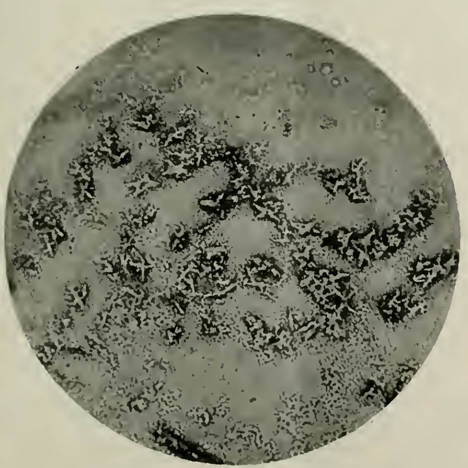


Fig. 12—Microphotograph of Co-enzyme.
(100 diameters)

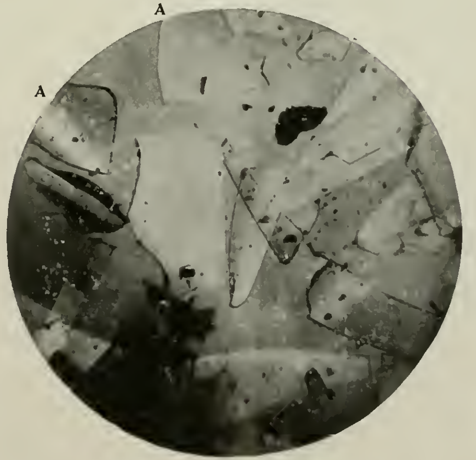
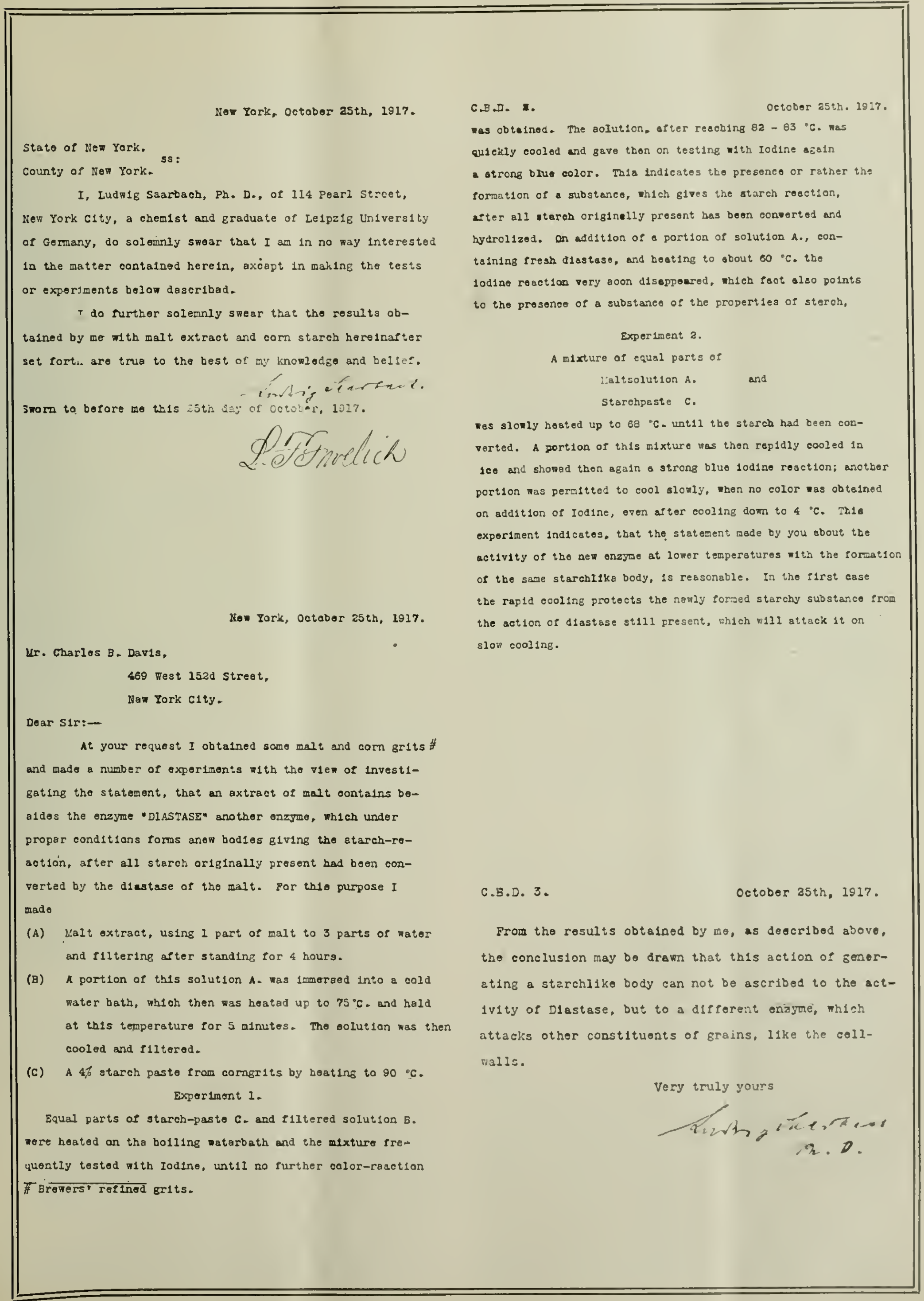


Fig. 13—The enzyme Diastase.
(AA) indicate play of iridescent colors.



New York, October 25th, 1917.

State of New York.
ss:
County of New York.

I, Ludwig Saarbach, Ph. D., of 114 Pearl Street, New York City, a chemist and graduate of Leipzig University of Germany, do solemnly swear that I am in no way interested in the matter contained herein, except in making the tests or experiments below described.

I do further solemnly swear that the results obtained by me with malt extract and corn starch hereinafter set forth are true to the best of my knowledge and belief.

Ludwig Saarbach.

Sworn to before me this 25th day of October, 1917.

L. F. Froelich

New York, October 25th, 1917.

Mr. Charles B. Davis,
469 West 152d Street,
New York City.

Dear Sir:—

At your request I obtained some malt and corn grits # and made a number of experiments with the view of investigating the statement, that an extract of malt contains besides the enzyme "DIASTASE" another enzyme, which under proper conditions forms anew bodies giving the starch-reaction, after all starch originally present had been converted by the diastase of the malt. For this purpose I made

(A) Malt extract, using 1 part of malt to 3 parts of water and filtering after standing for 4 hours.

(B) A portion of this solution A. was immersed into a cold water bath, which then was heated up to 75 °C. and held at this temperature for 5 minutes. The solution was then cooled and filtered.

(C) A 4% starch paste from corngrits by heating to 90 °C.

Experiment 1.

Equal parts of starch-paste C. and filtered solution B. were heated on the boiling waterbath and the mixture frequently tested with Iodine, until no further color-reaction

C.B.D. 2. October 25th. 1917.

was obtained. The solution, after reaching 82 - 83 °C. was quickly cooled and gave then on testing with Iodine again a strong blue color. This indicates the presence or rather the formation of a substance, which gives the starch reaction, after all starch originally present has been converted and hydrolized. On addition of a portion of solution A., containing fresh diastase, and heating to about 60 °C. the iodine reaction very soon disappeared, which fact also points to the presence of a substance of the properties of starch.

Experiment 2.

A mixture of equal parts of
Maltsolution A. and
Starchpaste C.

was slowly heated up to 68 °C. until the starch had been converted. A portion of this mixture was then rapidly cooled in ice and showed then again a strong blue iodine reaction; another portion was permitted to cool slowly, when no color was obtained on addition of Iodine, even after cooling down to 4 °C. This experiment indicates, that the statement made by you about the activity of the new enzyme at lower temperatures with the formation of the same starchlike body, is reasonable. In the first case the rapid cooling protects the newly formed starchy substance from the action of diastase still present, which will attack it on slow cooling.

C.B.D. 3. October 25th, 1917.

From the results obtained by me, as described above, the conclusion may be drawn that this action of generating a starchlike body can not be ascribed to the activity of Diastase, but to a different enzyme, which attacks other constituents of grains, like the cell-walls.

Very truly yours

Ludwig Saarbach
Ph. D.

Brewers' refined grits.

a Starch-Forming enzyme was discovered."

2. "The pretended Hemicellutase, etc. Not the slightest indication of its existence."

3. "In my opinion the entire article is erroneous."

This person went so far as to say that "if an enzyme has an optimum temperature of 82.5° C. we certainly should not expect that a mere subdivision of the substrate should reduce its optimum temperature over 60° C., that is, from 82.5 to 10-20° C."

He did not appear to know that diastase acts on gelatinized starch at an optimum of 60° C., while if the starch (substrate) be subdivided as in soluble starch the conversion will take place at 20° C., as in the Lintner method.

These are samples of the criticisms with which one has occasionally to deal. Yet here is one which gives some hope:—

4. "An enzyme which transforms hemicelluloses into starch appears to be a theoretical impossibility from a physiological standpoint, as it would have to effect changes which can only be attributed to the living cell."

This last admission, coupled with the fact that the starch-forming enzyme in question has been proven to exist (see affidavit), formed the basis and desire for the writer's research into enzymatic action and the chemical production of enzymes.

As before stated, such criticisms can be found throughout chemical literature. There has only to appear an article describing something new and the following is very likely to appear at the end of an abstract:

> Note—No experimental evidence is given in this paper justifying the author's claims, etc.—*Editor.*

Thus others who desire to rush into print are offered an excellent opportunity to follow with similar denunciations.

Arrhenius, in 1887, met with great opposition when he presented his doctrine of electrolytic dissociation.

Lately a disinterested party has confirmed the existence of Hemicellutase, and his affidavit, together with his results, is reproduced on page 165.

Although it was stated in the writer's former paper that Hemicellutase was capable of effecting the saccharification of raw cereals without boiling, yet after the republication of this article in *"Letters on Brewing,"* April, 1915 (a publication of Hantke's Brewing School) the writer was dumfounded to see a paper appear in the *"Communications of the Masters Brewers' Association of the United States"* for April, 1917, entitled "The Saccharification of Raw Cereal Mashes," in which the author attempted to take the credit of being the first to convert such raw cereals without boiling. The author of the above mentioned paper was one of the faculty of Hantke's School!

Good honest criticism should be and is welcomed at all times, but it should be backed by intelligent experiments and not by the unsupported opinion of those who, having attained some prominence in their chosen profession, believe that there is nothing new under the sun.

Author's Note on Hemicellutase.

Hemicellutase is more active at lower temperature than diastase; therefore starch is formed all the while the diastase is converting it (*Figs.* 1 *to* 6). But less starch is formed than the amounts converted; therefore, on cooling the mixture, the diastase becomes inactive, while the hemicellutase continues to form starch, and we again obtain the deep blue reaction with iodine. This color reaction is shown in *Fig. 7* of colored chart on insert. *Figs* 1, 2, 3 *and* 4 show the gradual disappearance of starch, while *Fig.* 5 is the dextrin reaction, and *Fig.* 6 the point where the diastase is just converting the starch formed by hemicellutase.

One should be careful not to heat the mixture of gelatinous and finely divided hemicelluloses too long after the disappearance of a starch reaction, for fear of converting them to sugar.

With vitrified cells, as in cracked corn, rice, and malt mashes, a temperature of 82.5° C. (optimum for this type of cell wall) is best suited for the transformation to starch. Just as diastase can convert to sugar soluble starch at 20° C. and gelatinous starch at 60° C.; so, too, can hemicellutase form starch between 10-90° C., according to the state of vitrification.

Fig. 15 shows the partial conversion of the cell wall to starch by the enzyme Hemicellutase.

Enzymes by Chemical Synthesis.

As a starting point for the chemical formation of enzymes, the writer has selected fresh egg albumin, since it contains the salts of potash, soda and calcium, so necessary for the formation of the co-enzymes, and traces of metallic salts, and also since it is easily obtainable, although other types of albuminous bodies, from wheat, barley, corn, milk, etc., may be employed.

Even egg albumin contains but small amounts of the selective nitrogeneous matter capable of forming enzymes.

In order to forestall arguments based on the ground that egg albumin, as the writer has used it, contains enzymes or co-enzymes in itself, he boiled the albumin and took the uncoagulated portion, precipitated it with alcohol, dissolved it in water, boiled the resulting solution again and then produced enzymes of high activity by the methods hereinafter described. All final tests were carried out in the presence of such antiseptics as toluene and chloroform to prevent any growths from mold and bacteria.

The resulting enzymotic products were highly phosphorescent in extremely dilute solutions, gave no reaction for albumin, but decided reactions for peptone, and possessed all the essential properties of enzymes as follows:—

1. Some soluble, others insoluble, in water.
2. Large quantities of substrate were acted upon with minute amounts of the enzymotic product,

and with very little weakening of the enzyme itself.

3. Active at very low temperatures, increasing in activity with rise of temperature and destroyed at elevated degrees approaching 100° C.
4. Precipitated by alcohol and salts.
5. Fix themselves to various substances by adsorption.
6. Sensitive to metals, acids and alkalies.
7. Resistant to antiseptics.
8. Some partly removed by dialysis, or porous filter.
9. Colloidal, and act as electrolytes or salts.
10. Affected by products of change.

The writer wishes to state before proceeding that mixtures of enzymes and co-enzymes are composed of a phosphorus anhydride which is the "KEY" described hereafter, and for which he suggests the name "Vitazymae," and a protective colloid combined with traces of magnetic metallic albuminois, and salts of potash, soda and calcium.

In all tests the writer has used a mixture of phosphorous and hypo-phosphorous acids as a source of anhydrid, and fresh egg albumin for the protective colloid.

EXPERIMENTAL.

Table I.

Tests with Alkaline, Neutral and Saturated* Albumin.

*As used above, "saturated" is when the albumin contains just sufficient mixed acids to reduce a solution of copper sulphate containing some soluble starch.

Solutions used:

(1) 0.014% soluble starch.
(2) 1 to 100 of 50% mixed acids.
(3) 10% albumin, alkaline, neutral and saturated.

(1)	(3) Normal Alkaline.	(3) 11.1% (2) Neutral.	(3) 50.3% (2) Saturated.
5 cc.	0.25 cc.	0.25 cc.	0.25 cc.
5 cc.	0.50 cc.	0.50 cc.	0.55 cc.
5 cc.	1.00 cc.	1.00 cc.	1.00 cc.
5 cc.	2.00 cc.	2.00 cc.	†
5 cc.	3.00 cc.	†	2.00 cc.
5 cc.	†	3.00 cc.	3.00 cc.
5 cc.	4.00 cc.	4.00 cc.	4.00 cc
5 cc.	5.00 cc.	5.00 cc.	5.00 cc.

†Indicates point of complete conversion of starch to sugar and dextrin at 70 F. after one hour by the following number of cc. of (3):

Alkaline	3.75 cc.
Neutral	2.75 cc.
Saturated	1.45 cc.

Notes: Iodine reactions immediately after mixing were as follows:

Alkaline	All Blue
Neutral	All Blue
Saturated	Blue up to 2.00 cc.

After boiling the Alkaline, Neutral and Saturated solutions of (3) no conversion of starch to sugar was obtained in any set of tests.

(1) and (2) mixed in varying proportions have no effect on the starch.

(2) is not affected by heating to elevated temperatures alone.

The amount of (2) required to render the albumin neutral or saturated varies with different eggs. Sugar by Fehling showed 80% maltose and 20% dextrin.

Table II.

Test with Large Amount of Soluble Starch.

Reagents used:

75 cc. of (3)
25 cc. of 0.135% soluble starch
0.56 cc. of 50% mixed acids.

The above was mixed and allowed to stand cold, testing with iodine and Fehling's solution at intervals with the following results:

	Iodine Reaction.	Fehling Reduction.
Immediate mixture	Deep blue	None.
After five minutes	Violet	Slight.
After ten minutes	Red violet	Distinct
After fifteen minutes	Red	Decided.
After thirty minutes	None	Heavy.
After sixty minutes	None	Heavy.

Note:—When working with small amounts of soluble starch, one must destroy the mixed enzymes by boiling immediately after the sugar is formed, otherwise the sugar splitting enzyme present will convert it to alcohol and carbonic acid and the resulting liquid will show very little or no reduction by Fehling solution.

The results obtained in *Table I* above show the presence of various enzymes, and it is the writer's purpose to show that the difference in quantity of albumin required for conversion between the "saturated" and the "neutral" is due to an enzyme similar to diastase.

The results from the alkaline, neutral and saturated egg albumin show conclusively that the enzyme preparation consists of a mixture of these bodies. This is further shown by the fact that it is capable of producing at least maltose, dextrin, peptone and alcohol.

By taking the difference between the neutral and the saturated egg albumin results (*Table I*) as due to diastase, we obtain figures as follows:

2.75 — 1.45 = 1.30 cc. of saturated egg albumin necessary to convert 0.0005 gr. soluble starch to maltose.

1.30 cc. of saturated egg albumin contains 0.065 gr. albumin, and this albumin contains 0.0000041% of diastase.

$0.065 \times 0.0000041 = 0.000000266$ gr. "Diastase," to convert 0.0005 gr. soluble starch to maltose.

$$\left.\begin{array}{lcl} 0.000000266 & & 0.0000180 \text{ “Diastase”} \\ & \text{or} & \\ 0.000500000 & & 0.0337500 \text{ Starch.*} \\ & & 0.0050000 \text{ Malt.*} \end{array}\right\} = 27{,}777. \text{ diastatic power.}$$

*When 0.03375 gr. soluble starch is converted to maltose by 0.005 gr. malt, at 70° F. after one hour, it is taken to equal 100° Lintner.

This agrees very closely with the calculated 26,595. below.

One part of this enzyme, therefore, converts 1,877 times its weight of starch into maltose, after one hour at 70° F., as against 6.75 for malt. Malt of 100° Lintner, therefore, contains only 0.0013% pure diastase. This is, no doubt, why it was never separated from malt in a pure state.

In the reactions showing the conversion of starch and water to sugar and dextrin (See Fig. 14), the molecular weight of soluble starch is taken as 32,400. The molecular weight of water is taken as 18.

It is only the loosely combined water of the "KEY" (*see Fig.* 8) that enters into combination with the starch. This the writer has found to be the case from the chemical reactions of the enzyme mixture at various times during the conversion of the starch.

Therefore, 32,400. is to 18 as 0.03375 gr. starch is to x or 0.0000188 gr. water entering into combination with the starch at each cycle of the "KEY."

$$\left.\begin{array}{ll}0.0000188 & \text{Water or enzyme}\\ 0.0337500 & \text{Starch}\\ 0.005000 & \text{Malt}\end{array}\right\} = 26{,}595 \text{ diastatic power.}$$

PREPARATION OF THE ENZYME.

Ten thousand grams of egg albumin (whites from about 30 dozen eggs) was treated with an equal volume of cold water and agitated until completely disintegrated.

This was filtered through cotton and the precipitate washed with cold water.

To this was added 1000 cc. of the 50% mixed acids, 100 grams sodium acetate, and a saturated solution of picric acid.

The voluminous precipitate of proteins was removed by filtration and the precipitate again washed with a saturated picric acid solution.

Filtrate and washings were evaporated to 500 cc. and 95% alcohol and ether added until a precipitate was obtained.

After standing two days in the cold, this precipitate was collected and washed with alcohol and ether until the filtrate was free from picric acid. After dissolving in cold water and evaporating over calcium chloride, the precipitate gave a residue of the mixed enzymes of 0.0013 gr. or 0.000013%.

This residue of mixed enzymes (*See Fig.* 9) was extremely iridescent and gave off the characteristic odor of albumin on ignition.

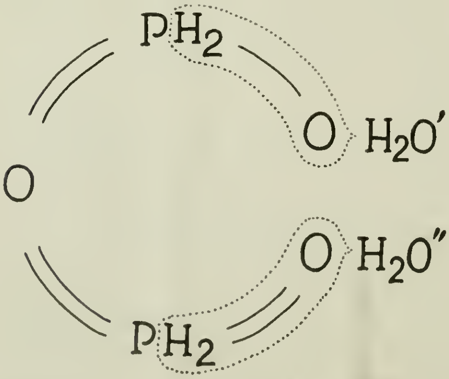


Fig. 8—Cycle or "KEY" of all enzymatic action illustrated graphically ("Vitazymae").

A portion gave an alkaline ash, showing absence of a nucleo albumin.

A water solution was highly fluorescent and phosphorescent, and traces were capable of immediately converting starch into sugar and dextrine, and finally into alcohol and carbonic acid gas.

The water solution, when filtered through parchment paper, resulted in a filtrate which had no activity, and a residue which had lost most of its activity.

On re-mixing, however, this became extremely active and similar to the original mixed enzymes.

Minute amounts, added to a dough consisting of wheat flour and water, and baked after the manner customary in making bread, resulted in a decidedly aerated loaf, as compared to one prepared with water alone. (*See Figs.* 10 *and* 11.)

The mixed enzymes, the separated enzyme and the co-enzyme are shown in the accompanying microphotographs, for the making of which the writer is indebted to Dr. James H. Stebbins.

The enzyme mixture is semi-crystalline. (*Fig.* 9.)

The co-enzyme is almost wholly crystalline. (*Fig.* 12.)

The enzyme "diatase" was chiefly amorphous (*Fig.* 13). The play of colors may be seen in the rings A A.

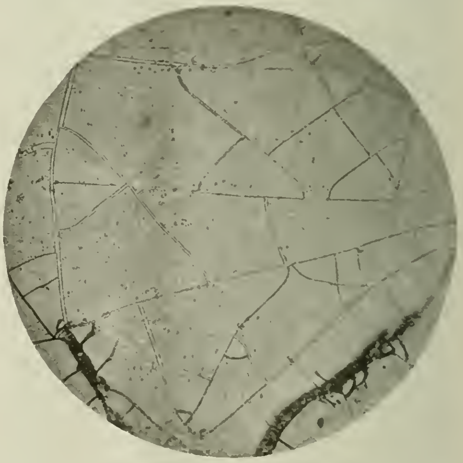


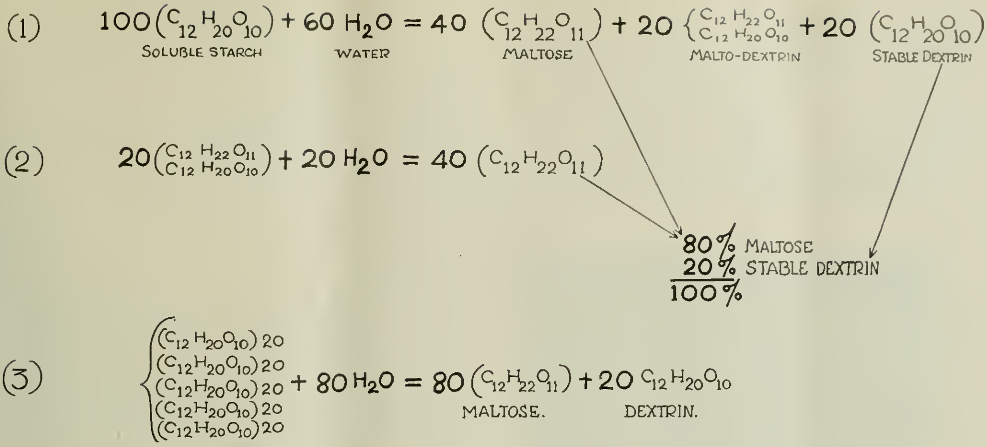
Fig. 9—Microphotograph of residue of mixed enzymes, from which Figs. 12 and 13 were obtained (100 diameters).

A minute quantity of the mixed enzymes added to some sterilized malt wort and warmed to about 20° C. immediately caused a generation of carbonic acid gas which increased to foaming within five minutes.

This mixture on distillation under a reflux condenser showed unmistakable presence of ethyl alcohol, by the usual chemical tests.

Roses, decolorized permanently with sulphurous acid, washed free of acid and the last traces destroyed with hydrogen peroxide, were immediately restored to their original glory of both color and fragrance by small quantities of the mixed acids, sufficient to form enzymes within the petals. The coloring may be extracted from leaves and flowers by this method.

Green fruit immersed in a 1 to 200 dilution of the mixed acids ripens very quickly from the same formation of enzymes in a high state of activity.



$$(1)\quad 100\underset{\text{Soluble starch}}{(C_{12}H_{20}O_{10})} + 60\underset{\text{Water}}{H_2O} = 40\underset{\text{Maltose}}{(C_{12}H_{22}O_{11})} + 20\underset{\text{Malto-dextrin}}{\left\{\begin{matrix}C_{12}H_{22}O_{11}\\ C_{12}H_{20}O_{10}\end{matrix}\right.} + 20\underset{\text{Stable Dextrin}}{(C_{12}H_{20}O_{10})}$$

$$(2)\quad 20\begin{pmatrix}C_{12}H_{22}O_{11}\\ C_{12}H_{20}O_{10}\end{pmatrix} + 20\,H_2O = 40\,(C_{12}H_{22}O_{11})$$

$$\begin{array}{rl} 80\% & \text{Maltose}\\ 20\% & \text{Stable Dextrin}\\ \hline 100\% & \end{array}$$

$$(3)\quad \left\{\begin{matrix}(C_{12}H_{20}O_{10})\,20\\ (C_{12}H_{20}O_{10})\,20\\ (C_{12}H_{20}O_{10})\,20\\ (C_{12}H_{20}O_{10})\,20\\ (C_{12}H_{20}O_{10})\,20\end{matrix}\right. + 80\,H_2O = 80\underset{\text{Maltose.}}{(C_{12}H_{22}O_{11})} + 20\underset{\text{Dextrin.}}{C_{12}H_{20}O_{10}}$$

Fig. 14—Equations showing steps in the hydrolysis of starch to maltose and dextrin.

PREPARATION AND SEPARATION OF THE SYNTHETIC "DIASTASE"

Ten thousand grams of egg albumin (whites from about 30 dozen eggs) was treated with an equal volume of cold water and agitated until completely disintegrated. This was filtered through cotton and the precipitate washed with cold water.

Filtrate and washings were treated with 225 cc, of 50% mixed acids (sufficient to just neutralize), which caused a precipitate to tumble out of solution.

This precipitate was separated by filtration and washed until free from albumin and peptone. This was indicated when Tanret's reagent gave no reaction. The precipitate was then dissolved off the filter with excess of the mixed acids (more than sufficient to "saturate"). The filtrate, measuring 100 cc., was then treated with a saturated solution of picric acid and the precipitate removed by filtration. The filtrate and washings, measuring 200 cc., were treated with 200 cc. absolute alcohol and 300 cc. absolute ether.

No precipitate was visible until after a lapse of two days. After four days in the cold, the deposit of "diastase" was collected, washed with a mixture of alcohol and ether, and dissolved off the filter and evaporated over calcium chloride.

The residue weighed 0.00041 gr., the equivalent of 0.0000041% "diastase."

This "diastase" (*Fig.* 13) was extremely active on soluble starch in the cold, converting 0.03375 gr. to sugar in one hour at 70° F. with 5 cc. of its 1% solution. This proves the correctness of the "KEY," and also that an excess of protein, as present in eggs or malted cereals, is without effect on its action.

These reactions tend to point to the formation of enzymes in plant and animal life, through the presence of these mixed acids secreted during germination or growth.

By following the above method, as for "diastase," and salting out the slightly acid egg albumin with sodium sulphate at 90° F., a product is obtained having properties similar to pepsin.

The type of albumin in eggs, which goes to form these enzymotic bodies, is a phosphorized mucoid or a nucleoized glycoprotein, carrying its phosphorus as an anhydrid. Only minute quantities are required to act as the protective colloid.

Egg albumin contains but minute quantities of this selective mucoid capable of carrying the phosphorus anhydrid, and although the "KEY" to the enzymes is dependent wholly on its anhydrid, still the mucoid is absolutely required as its protective colloid.

This phosphorus constituent of the "KEY" is in most cases undetectable, but in other cases, as in samples of the writer's preparation about three years' old, the anhydrid is gradually changed into a detectable form.

Fats, Salts and Carbohydrates of many types, when mixed with the acids, fail to produce active bodies, as it is absolutely necessary to add the above-mentioned albuminous matter to obtain an enzymotic action. This goes to prove that nitrogen is essential to the production of enzymes.

"KEY"	+	**Substrate**	=	**Product**
to the enzymes (Vita-zymae)		Starch		Maltose & Dedtrin.
		Sugar		Alcohol & CO_2.
		Protein		Peptones.

CHEMICAL ACTION OF THE "KEY" (Vita-zymae)

The half-bound molecule of water is active up to the temperature of destruction of its protective colloid. During the range of activity the water is split off and immediately combines with the substrate (1).

The unsaturated anhydrid again absorbs its lost water and thus forms the cycle of the "KEY" (2) which continues until such time as the temperature or other disturbing influence destroys the protective colloid, when the "KEY," or anhydrid, absorbs water, is hydrolyzed to acid (3) and rendered permanently inactive. A very feeble acid reaction appears and a very faint blue coloration is obtained by molybdate reagent, indicating a hypophosphite. Very high temperatures or ignition of the enzyme splits off all three molecules of water, leaving the neutral phosphorus oxid P_2O. See (4).

(1) $H_4P_2O_3 - H_2O = H_2P_2O_2$, the unsaturated and unstable compound, and this compound plus water:

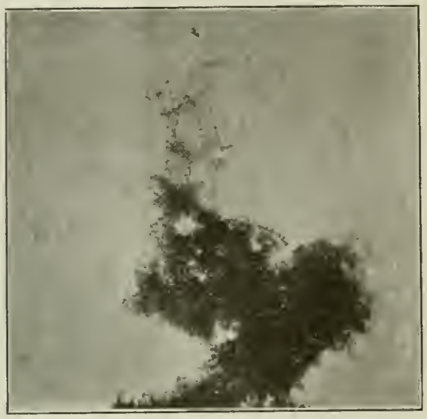


Fig. 15—Showing partial conversion of the cell-walls to starch by the enzyme Hemicellutase.

(2) $H_2P_2O_2 + H_2O = H_4P_2O_3$, thus completing the cycle of the "KEY."

(3) $H_4P_2O_3 + H_2O = 2H_3PO_2$, and

(4) $2H_3PO_2 - 3H_2O = P_2O$, which is incapable of further absorption with water.

At times, especially when sugar is being fermented to alcohol, the writer has found traces of hydrogen phosphide and liquid hydride (PH_3 and P_2H_4), which accounts for the destruction of some enzymes under the influence of sunlight.

FORMATION OF ALCOHOL BY SYNTHETIC ENZYME.

0.0015 gr. of the mixed enzymes introduced into a sterilized solution containing in part 8.5% maltose, 0.12% acidity, 0.20% albumises and proteoses, 0.04% peptones, 0.37% amino compounds and 0.16% phosphated ash, immediately set up a copious generation of CO_2, and on distillation gave an appreciable amount of ethyl alcohol.

Another test with a boiled enzymes solution gave a negative result.

Antiseptics did not retard the reaction.

Slight elevation of temperature, created increased action and foaming.

Unlike yeast of even zymase, the reaction is immediate.

CONCLUSIONS.

An enzyme is only as strong as its protective colloid; when this is destroyed, its anhydrid is split up and the enzyme rendered permanently inactive, unless more anhydrid is added.

The writer has found that the mixed acids are best suited to the synthetic formation of a mixture of enzymes.

The mixture thus formed can be separated by the described methods.

Too much mystery has been connected with enzymes in general.

The anhydrid is devoid of acidity, as are also the enzymes and the oxid (P_2O) formed by the destruction of the protective colloid.

The water is set free "in situ" and immediately combines with the substrate. The reabsorption of water by the "KEY" continues as long as any substrate is present, or until a destructive temperature or agent is introduced for the required period of rest.

This re-constituting of the "KEY" indicates that enzymes are catalytic and contain enormous quantities of available hydrogen ions; also that they do not combine permanently with their substrates.

The enzyme and substrate being in a state of adsorption accounts for the voluminous amount of substrate attacked by minute quantities of enzyme. This is, of course, due to enormous surface action.

The presence of the neutral and insoluble oxid P_2O in the "killed" enzyme explains the reason why Pfeffer could not detect enzymes in the vapor formed by heating them with water.

The continued cycle of the "KEY" proves that there is no chemical relation between the quantity of enzyme and substrate aside from concentration.

The reason why previous attempts to purify enzymes have resulted in weakening their action, is because of the partial destruction of the protective colloid.

All enzymes have the same general chemical composition, their specificity being due simply to the manner of the linking of anhydrid and protective colloid.

Co-enzymes are chiefly crystalline. (*See Fig.* 12.)

Enzymes devoid of co-enzymes are amorphous.

Enzymes exhibit intense iridescence. (*See Fig.* 13, *AA*, showing the play of colors.)

The writer has found that when the enzyme is retarded by the presence of cleavage products, it can be again actuated by precipitating the enzyme and adding fresh anhydrid.

The selective albumin described in this paper is the zymogen, the anhydrid being the activator. Very little of this selective colloid is present in the pure enzyme, it requiring only minute amounts to protect the anhydrid.

Hydrogen peroxide is immediately decomposed by traces of the mixture of enzymes, which indicates a strong catalytic activity.

(*Concluded on page* 196)

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors. Synthetic Medicinals, Flavors and Perfumes. Explosives, Photographic Developers.

Edited by
THOMAS H. NORTON, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

George H. Bruce, LL.B., Keystone Fibre Products Co., Inc., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hebden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles.

H. Gardner McKerrow, of E. F. Drew & Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

EDITORIAL COMMENT

German Color Patents

Applications are being regularly filed under the "Trading with the Enemy Act," for licenses to manufacture in this country various chemical products covered by patents issued to German inventors during recent years. One patent out of every 30 granted at Washington is to a German inventor. The proportion among chemical patents is, however, much larger, as one out of every five German patents is of a distinctly chemical nature.

During the decade 1900-1910 the American chemical patents isued to Germans were divided as follows: Alkalies and chlorines, 4; bleaching and disinfecting liquors, 12; chlorates, 1; carbides, 3; carbon dyes, 701; bleaching, 17; dyeing processes, 79; dyes, 10; mercerizing, 10; mordants, 13; mineral acids, 62; fire-extinguishing compounds, 4; metalloids, 14; apparatus, 10; salines, 98; ammonia, 27; soda and potash, 9; carbon compounds, 450; nitro-compounds, 28; hair dyes and tonics, 2; extracts, 18; internal remedies, 52; topical remedies, 20; insecticides, 6; disinfectants, 19.

It will be noted that artificial dyes, dyeing processes, carbon compounds and nitro compounds make up over two-thirds of the total number.

About 10 per cent. of the colors currently in use before the war were under patent protection in 1914. The most important of these colors are in the indanthrene class, the exceedingly fast vat colors, which are so highly valued by cotton manufacturers. Salvarsan and a few other important synthetic medicinals are also under patent protection.

The number of inquiries in regard to the method of securing the permission to manufacture under these German patents has become so large that the Federal Trade Commission has issued the following license rules:

Applicants for a license under patents or copyrights owned or controlled by an enemy or an ally of an enemy are required to file a verified statement with the Federal Trade Commission in concise and non-technical language, covering the following points, stating in each instance the facts upon which any conclusion may be based.

(a) If an individual, that he is a citizen of the United States. If a corporation, that it is organized within the United States.

(b) That the patent or copyright desired to be licensed is owned or controlled by an enemy or an ally of an enemy.

If it is claimed that the patent or copyright is controlled by an enemy or ally of an enemy, the nature and origin of the control should be plainly stated, whether by contract, agency, stock ownership or otherwise.

(c) There shall be attached to the application a Patent Office copy of the patent and a certified abstract of title to it, or a specimen of the copyrighted article and a certified copy of the copyright entries and, in the case of a patent, of a certified copy of the petition and all powers of attorney in the file of the application.

(d) That licensing the applicant is for the public welfare. Specifically, that there is a demand for the patented or copyrighted article or the product of the patented process which is not being met.

(e) That the applicant is able to make or cause to be made the patented or copyrighted article or exercise the patented process. Specifically, that the applicant is technically and otherwise equipped to undertake or procure the manufacture or operate the process and is in fact able to do so.

(f) That the applicant intends to do so in good faith.

(g) The application must be verified by the person applying for the license, and in the case of a corporation by an officer thereof acquainted with the facts recited.

Each application shall be accompanied with a remittance of $100.

A separate application is required for each patent or copyright.

The application should be prepared in duplicate and, for convenience in filing, or good unglazed paper, 8 by 10½ inches, directed to the Federal Trade Commission, Patent, Trade-mark and Copyright Division, and may be transmitted by mail or delivered personally. Personal attendance at the outset is not necessary. If any hearings are desired, notice of them will be given.

In every case where practicable notice of applications for license will be given to the attorney of the patentee or copyright proprietor whose name appears in the file of the application in the Patent Office or the office of the Register of Copyright.

The burden of establishing affirmatively the facts upon which, under the terms of the act, licenses may be granted is placed upon the applicant for license.

Theact provides and the Executive order vests in the Federal Trade Commission the duty of prescribing the conditions of the license.

Only non-exclusive licenses will be issued unless the public interest shall otherwise require.

The act provides (sec. 10 (c)) that licenses shall continue during the terms fixed in the license, or, in the absence of any such limitation, during the term of the patent * * * or copyright registration under which it is granted, and that upon violation by the licensee of any provisions of the act, or the conditions of the license, after due notice and hearing, the license may be canceled.

Licenses for the use of trade-marks, prints and labels will be granted only under exceptional circumstances. Applications for licenses under the following conditions will be entertained:

1. Where the alleged trade-mark is the name of a patented or copyrighted article and a license is granted under the patent or copyright.

2. Where the alleged trade-mark is the name of an article manufactured under an expired patent or copyright.

The act provides that the license fee shall not exceed $100 and not exceeding 1 per cent. of the sum deposited with the alien property custodian. This fund is an amount not to exceed (a) 5 per cent. of the gross sums received by the licensee from the sale of the licensed subject matter, or (b) 5 per cent. of the value of the use of the licensed subject matter as established by the Federal Trade Commission.

The licensee shall file with the Federal Trade Commission semi-annually, on January 1 and July 1 of each year, and oftener if required, a full statement of the extent of the use and enjoyment of the license, and of the prices received from the sale or use of the subject matter of it, and within thirty days thereafter the licensee shall pay to the alien property custodian not to exceed 5 per cent. of the gross sums received from the sale of the licensed subject matter, or if the Federal Trade Commission so orders not to exceed 5 per cent. of the value of the use of the licensed subject matter as established by the Federal Trade Commisison.

A careful analysis of the legislation in this connection and of the rules for putting it into effect shows that an earnest effort is being made to ensure the welfare of the nation during a great emergency without infringing seriously the rights of enemy inventors.

We can confidently look forward to important industrial developments as a result of the recent legislation, developments which will do much to stimulate invention and further the expansion of our chemical manufacturers, freeing them from the former dependence upon Germany.

It is important to bear in mind that there is a notable differenec between the requirements for German and for American patents, especially in connection with chemical inventions. The main points are brought out in the following study of the subject made recently by the "Scientific American":

> Our Government has been very liberal to inventors. It has sought in every way to advance science and knowledge. The United States is one of the few coutries that is willing to give a patent to an inventor without requiring him to operate his invention within the country. Furthermore, we are very liberal in our manner of granting patents. are very liberal in our manner of granting patents. A patent is supposed to be granted to an inventor as a reward for advancing public information. An inventor is supposed to make a complete exposition of his invention so that the public may reap the benefits of it, and, as a reward for this disclosure, he is given a monopoly for a period of 17 years. However, there is a defect in our system which requires merely that the inventor disclose a workable process or machine and not necessarily a commercially practical one. German inventors have been quick patenting of chemical processes. They draw a distinction between "process" and "technique." As long as our statutes require merely that the process be disclosed the German inventor will make a disclosure of his chemical processes to an extent

just sufficient to come within our requirements, but will withhold, as trade secrets, many steps in the process which are essential to a commercial exploitation of the invention. Our statutes, furthermore, permit an inventor to patent separate steps in a process, and this the German inventor frequently does, thereby covering certain vital parts of his process which afford him absolute protection without disclosing the intermediate steps which are necessary to a full knowledge of the process of manufacture.

The German Government, on the other hand, insist upon a complete disclosure. The following abstract of the requirements in this respect, of the German law, furnished by Brandon Bros., shows how fully the applicant of a chemical patent in Germany must explain his process of manufacture:

"German applications for new processes of the manufacture of chemical preparations must be accompanied by a sample of these preparations, and also of the compounds used in the process, so far as such compounds may be new. These samples, which should weigh about 8 to 10 grams, should be put up in glass bottles of about 30 millimeters diameter and 80 millimeters entire height, closed with a glass stopper and having the seal of the applicant, and bearing an exact description of the contents.

"For coloring matter prepared from tar, a sample of dyeing on wool, silk, or cotton must be transmitted. These samples should be attached in a suitable way on a sheet of cardboard measuring 330 millimeters by 210 millimeters (13 by 8¼ inches). For each coloring matter, samples of dyeing in three different shades must be filed; for coloring matter permitting of quantitative analysis, one of those samples should be dyed with one per cent., and the other two samples might be weaker or stronger, according to the power of the dyeing matter. These samples must be accompanied by a description of the method of dyeing(distinctly give ing the degree of concentration of the dye liquor, the mordant, if any has been used, the temperature, etc., stating also whether the dye liquor has lost its color, or still contains more or less dye matter. Directions concerning the method of dyeing will not be published in the patent, except upon the special request of the applicant."

Thus while the German Government requires a complete disclosure of the "technique" of a process before granting a patent, it does not give out this disclosure to the general public. This increases the problem that faces us at the present time. The "Trading with the Enemy Act" enables our manufacturers to make use of German patents, and there are about 20,000 patents affected by the Act. But we find that many of these patents are not complete disclosures. Before our manufacturers can use them commercially much time and capital must be expended in experiment. This would deter our manufacturers from applying for licenses were they not assured that they would be permitted to continue to use the inventions after the war. The statute provides that unless the license is limited in term it shall last the life of the patent.

It will be evident thus, that this statute is not an act of confiscation except in so far as the enemy inventor will be obliged to permit the use of his patent even after the war, but will receive royalty for such use. We do not know what Germany is doing with American patents. Certainly Germany is not confronted with the same difficulties that we are. American patents in Germany have to do mainly with machinery and have no bearing on the health or safety of the nation. On the other hand, there are German patents in this country on salvarsan, veronal, novocaine, etc., which are important medicines. We must permit operation under these patents because they are necessary to the health of the people. If Germany should look upon the "Trading with the Enemy Act" as one of confiscation and attempt reprisal, we can do nothing until the end of the war when we shall demand adequate indemnities to settle for the losses of our own citizens.

Our Government is going to regulate the manufacture under the new Act, in the strictest possible way, requiring rigid inspection and submission of samples. It will, if necessary, even fix the prices, on articles necessary to the health of the military and naval forces as the successful prosecution of the war and require a reasonable price in all cases, because the purpose of this Act is not to enrich the manufacturer, but to benefit the public at large. In the matter of drugs, it is now proposed that the supervision and control of their manufacture be taken over by the United States Health Service so far as their inspection is required. No license will be permitted until the Board is assured that the manufacturer is capable of manufacturing the product in a satisfactory way, and at a price that will be fair to the public.

Swedish Dyestuff Industry.

Among the countries making a pronounced effort to attain material freedom from dependence upon the German dyestuff industry, Sweden is now to be enrolled. The consumption of synthetic colors is not very large, about 900 short tons annually. It is felt, however, that it is sufficient to warrant the establishment of a domestic industry, and a company has already been organized to finance the project.

Sweden lacks the raw material, as the country has no coking coal. It is, however, richer in chemicals than Switzerland which possesses a flourishing dyestuff industry despite her poverty in material.

The plans of the Swedish company embrace competition in foreign markets.

How the Government Views the Growth of American Chemical Industry.

Never before in our history have the various branches of the government devoted so much attention to the domestic chemical industry and to its wonderful possibilities. There is a general and generous recognition of the fact, that the present world conditions place it within our power to expand the industry at a rapid rate, to make it capable of meeting the great bulk of home demands and to win a place in foreign markets which can be maintained when European competition again comes into play.

The far-reaching fiscal legislation of September, 1916, in the interests of American coal-tar chemicals has paved the way for capital and enterprise to enter upo nthe manufacture of artificial dyestuffs, of synthetic medicinals and allied products, with a degree of confidence which assures final success. The fact that for the time being and for an indefinite period in the future, American consumers of colors are forced to rely upon the domestic output, affords the needed opportunity for establisting those confidential relations between manufacturer and purchaser which are all important for the future of the industry, and which, under normal conditions, could be attained slowly and at great cost, in the face of bitter foreign competition.

These facts and the intimate connection between the production of high explosives and the manufacture of coal-tar colors are now fully recognized by the authorities at Washington and there is a hearty readiness on their part to do all that is necessary to further the good work.

The Secretary of the Interior, in his annual report, devotes an unusual amount of space to our chemical industry, and from his summary of what has been accomplished the following may be quoted:

!ée(.c,v!!!! shrd lucmfwyp shrdl cm vbgkqjvbgk

"Before the war 90% of the artificial colors and dyes were imported, five or six concerns with 400 operatives producing 3,300 short tons per year. Now there are over 90 enterprises, each making special colors, and 100 concerns making crudes and intermediates.

"Sulphuric acid, the chemical barometer, has doubled in production. In 1916, 6,250,000 tons of 50 deg. Be. were produced. The estimate for 1917 is much greater, and the production for 1918 will again greatly increase.

"By-product cooking doubled its capacity in the last three years, yet in 1918 the United States will make half her coke in beehive ovens. Light oil, which contains the benzene and toluene needed for explosives, jumped from 7,500,000 gallons in 1914 to 60,000,000 gallons in 1917, and is again being largely increased. Ammonia production has increased 100% in three years and the visible supply is insufficient to meet the demand.

"Gasoline production has increased from 35,000,000 to 70,000,000 barrels per annum since 1914.

"Potash importation from Germany was stopped by the war, which has stimulated production in this country. The production from January to June, 1917, was 14,023 short tons of potash. This is a small production, but sodium salts have been substituted for almost all purposes except agriculture. Shortage of labor and coal is seriously interfering with the potash-brine evaporation in Nebraska, which was yielding about 90 tons per day.

"The production of explosives and consequent consumption of nitric acid has increased enormously. The nitric acid is still almost entirely made from Chili saltpetre, but synthetic nitrogen plants are under process of construction, and we have large quantities of coal-tar ammonia which can be used for munitions if necessary.

"Before the war 40,000 tons of barite were imported from Germany for the manufacture of lithopone. Now five companies are producing this article from deposits in Tennessee, Kentucky, Virginia and Missouri.

"American chemists have met the country's needs as ably and completely as did the chemists of Germany. We can go forward with every confidence that there will be no serious shortage of the many chemical products required for domestic consumption."

The new Tariff Commission devotes an even larger portion of its annual report to this subject. It fully recognizes the fact that the most important field for its activity will be in connection with adequate legislation to ensure the continuous expansion of our chemical industry and its future permanence. The industries, says the Commission, "will have to face new conditions on the conclusion of peace. In some branches there will be surplus capacity and a probability of sharp international competition." Surplus capacity will exist where acids and other substances have been produced in great quantities for munitions. Demand for these will be cut down. But there should be no reduction of the output of chemicals, drugs, dyes, etc., now made here in place of those imported before the war.

There is evidence in the annual reports that the importance of preserving and defending the new industries hereafter, when peace conditions are restored, is clearly seen at Washington. They should be fostered not only because they have made us independent of the old foreign sources of supply, but also for the reason that their growth has involved the saving of much valuable material which we formerly threw away, at the coke ovens, smelting mills, and elsewhere.

With this attitude at Washington, which reflects general political opinion, quite irrespective of faction or party, we may look forward with full confidence to the future. Should additional legislation be required to protect certain branches during the formative stage, it will encounter no serious opposition. The nation is determined to emancipate itself definitely and finally from dependence upon Germany for its chemicals as well as for many other articles. The possibility of attempts to throttle the young and growing industry by resorting to the methods of "unfair competition" on the part of foreign rivals, is now effectively precluded by adequate legislation. At the same time the extent to which capital has been invested in our chemical industry, especially in the manufacture of coal-tar products, assures consumers that there will be free play of competitive effort in meeting the needs of the domestic market.

Efficiency of American Color Chemists.

There has been an assumption by many that American chemists are not fitted temperamentally or by training to deal effectively with the problems connected with the symmetrical building up of our national dyestuff industry. This prejudice is fast disappearing in the face of accomplished facts, although, in fairness, we must recognize the valuable assistance rendered by chemists of Swiss, German and Alsatian origin.

The head of one of our largest color firms recently stated that he could detect no difference in professional ability between the young chemists employed in his laboratories of American birth or of foreign origin.

In a recent issue Cotton (of Atlanta, Ga.) outlines the reasons for the widespread opinion cited above. We quote:

"As to the misunderstanding regarding the American chemist and the former popular belief in his inferiority in the dyestuff line, this is easily understood. It should be noted that chemistry is divided into two distinct branches, organic and inorganic, and in Germany the principal and most important industry is the making of dyestuffs (which is organic chemistry). Most German students in chemistry after graduation seek positions in coal-tar plants, as there are no mines in Germany, and, therefore, less call for general chemists of the inorganic line. The universities naturally cater for the desires of the students and the wants of the country, and, therefore, the principal courses are organic chemistry, while the shorter courses are inorganic.

"In this country it is exactly the reverse. We had no dyestuff plants, but did have large industries of every other line, most of them requiring inorganic chemists. We called for technical men for our copper mines and refineries, iron works, and for heavy inorganic chemical plants. Therefore, the demand being for inorganic men, our universities and technical schools taught mostly inorganic chemistry, and our chemists averaged higher than the Germans in this branch of the science. Nevertheless, Americans who took up organic and dyestuff chemistry in former years had not the slightest trouble in mastering the science, and I recall that one of the chief chemists in the largest dyestuffs plant in Germany for a number of years was an American.

"Not only have we crossed the tape in the dyestuff line, but we have actually gone ahead in the working of vegetable oils (another branch of organic chemistry). Before the war all high-grade soluble oils for textile work were made from castor oil, mostly from Germany, and known as monopol oils (a German patent), or made in this country from imported castor oil. Today one Philadelphia concern is making a hydroxy oil which is made on an American process from American oils exclusively, and is superior to the heretofore imported product."

The Profits of European Dyestuff Companies.

It is a fact of some interest that the great German dyestuff companies, despite the cessation of most of their export trade, report a volume of business and a rate of profit quite equal to the figures of normal times, and in some cases even a marked advance is indicated. The same conditions exist in the rival industries of Switzerland, France and England.

In the case of the German works, it would appear that the actual production of colors is for the time being a purely secondary consideration. Their efforts have been concentrated, since 1915, chiefly on the manufacture of munitions and of hospital supplies, as well as of the many accessory chemicals needed for military purposes. During the close of 1914 and for part of 1915 there was a marked set-back in the activity of all the establishments. For the past two years, however, their productive capacity has been pushed to the utmost. This fact is quite evident from the annual reports issued during 1917, covering either 1916 or portions of 1916 and 1917. As a rule these reports do not reveal much of what is actually being done in the various plants, but confine themselves to financial results. Most of the companies make generous provision for sinking funds and operatives' welfare funds, and considerable amounts are placed in reserve for the uncertainties of the period immediately following upon the end of the war.

The largest German company, the "Badische

Anilin und Soda-Fabrik," reports profits of $6,300,000, as compared with $4,720,000 during the preceding year. The dividend rate was raised from 20% to 28%. The company placed $710,000 in its reserve fund and contributed $500,000 to the relief of crippled soldiers. An important acquisition during 1916 was the stock of the large lignite mine at Rattmansdorf with extensive plants for the manufacture of briquettes, paraffin and heavy oils. The company produces synthetic ammonia, by the Haber process, on a vast scale, and the nitric acid obtained from this by oxidation, according to Ostwald's method, is the chief factor in assuring the ability of Germany to meet the huge demands for powder and explosives required in her military operations.

The "Farbenfabriken vorm. Friedr. Bayer & Co.," of Leverkusen, reports profits of $5,100,000. A dividend of 28% was declared on the capital of $13,000,000. This is the same figure as in 1912 and 1913. In 1914 the rate was 19% and in 1915 20%. The company had added $1,300,000 to its reserves. It gives, also, $500,000 to the fund for crippled soldiers, and remembers generously the children of all its employes killed in the war.

The "Farbwerke vorm. Meister Lucius & Brüning," of Hächst, earned $5,760,000, as compared with $3,700,000, the year before. The dividend rate was raised from 20% to 25%. Synthetic medicinals constitute an important feature in this company's output.

The "Actien-Gesellschaft für Anilin-Fabrikation," of Berlin, reports profits of $1,740,000, as compared with $1,200,000 in 1915. Its dividend was also 25%.

"Kalle & Co., Aktiengesellschaft," of Biebrich, reports a gross revenue of $720,000 against $1,030,000 the year previous. Of this but $310,000 was devoted to dividends, the rate being 10% as in preceding years. The amount of $170,000, paid by this company in the form of taxes, throws an interesting sidelight on the burden of taxation in Germany at present.

The "Chemische Fabriken vorm. Weiler-Ter Meer," of Merdinger, earned $520,000, an advance upon the sum of $350,000 in 1915. The dividend rate was 12%.

The "Farbwerk Mühlheim, vorm. A. Leonhardt & Co.," of Mühlheim, reports a profit of but $43,000 and paid a dividend of 4%.

Two of the leading companies, "Leopold Cassella & Co.," of Frankfort, and the "Chemische Fabrik Griesheim-Elektion," also of Frankfort, have not published their annual reports. Both, especially the latter, have been, however, very active.

A few of the other prominent German chemical companies might be mentioned in this connection, in order to present a more complete picture of conditions in the Empire.

The "Deutsche Gold und Silberscheide-Anstalt," of Frankfort, reports a gross revenue of $2,700,000 ($2,400,000 in 1915). Its dividend rate was 27% and $1,200,000 was placed in the reserve fund.

The "Vereinigte Chemische Fabriken," of Mannheim, paid a dividend of 27½% on its capital of $1,200,000.

The "Chemische Fabrik Schering," of Berlin, largely devoted to medicinal and photographic products, paid a dividend of 16% (12% in 1915). It carries a reserve of $1,200,000, over three times the amount of its profits for the year—$380,000.

The "Chemische Fabrik von Heyden," of Dresden, earned $930,000, over double the profits of 1915, and paid a dividend of 25% on its capital of $1,470,000. This company has erected, near Görlitz, large works for making nitric acid from atmospheric nitrogen.

The "Saccharinwerke Fahlberg, List & Co.," earned $280,000, as compared with $180,000 in 1915. The dividend rate increased from 10% to 12%.

Establishments devoted exclusively to the manufacture of explosives have naturally earned large amounts. The leading representative in this class, the "Verenigten Köln-Rottweiler Puloverfabriken," had a net revenue of $3,500,000, about the same as in 1915. The dividend that year was 35%. This was decreased to 20%, while $1,200,000 was added to the reserve fund and $1,700,000 was carried to the next year's account.

This summary statement gives ample evidence that the chemical industry of Germany, while earning exceptionally high profits, is displaying a careful, conservative caution in accumulating heavy reserves. The question naturally arises as to the extent to which these reserves have been invested in Government bonds, and the prospective value of such investments when the war ceases.

General confidence in Germany in the future of the dyestuff industry is, however, manifested by the continued high quotations of the stock of the leading companies. The "Badische" and "Bayer" are quoted at 630; "Hoechst" at 540; "Actiongesellachaft," Berlin, at 525; "Griesheim-Elektron" at 470, and "Weiler-Ter Meer" at 280.

It is quite pertinent in connection with the above survey to briefly note the status of the dyestuff industry in the other European countries.

The leading Swiss company, "La Société pour l' Industrie Chimique" of Basel reports for 1916-17 a net revenue of $1,620,000 on a capital of about $2,000,000, after generous provision for sinking funds, funds for pensions, etc. The dividend of 25% was supplemented by a bonus of 250 francs per share (presumably of 1,000 francs). The income in 1915-16 was less than two-thirds of the above amount, and the dividend rate was 24%.

The "Chemische Fabrik vorm. Sandoz & Co.," of Basel, reports an even more prosperous year. Its net income was $1,850,000. Its dividend of 25% was supplemented by a bonus of 1,000 francs per share (presumably on shares of 1,000 francs) as was also the case the year before.

The other two companies in Basel, "Farbwerke vorm. L. Durand Huguenin & Co.," and "Anilinfarben und Extract-Fabriken vorm. J. R. Geigy," report likewise a prosperous year, although details are not furnished.

The results obtained in Switzerland are all the more creditable, and even astonishing when it is borne in mind that the little republic is totally dependent upon outside sources for its fuel and for the raw material required in the coal tar chemical industry.

In France the leading company engaged in the production of colors is "La Société des Matières Colorantes et Produits Chimiques de St. Denis." Its profits in 1916 were $730,000, as compared with $522,000 the year previous. The capital of $875,000 has been increased to $1,400,000.

"La Société Chimique des Usines du Rhône" has become a powerful factor, producing colors and a variety of chemicals. Its sales in 1916 exceeded $24,000,000. The profits were over $2,100,000. Of this sum $1,000,000 was placed in the reserve fund. In 1915 the amount reserved was $600,000. The sum available for dividends was $1,200,000 as compared with $80,000 in 1915.

"La Campagnie des produits Chimiques d'Alais et de la Camarque" is devoted to inorganic chemicals and explosives, and has a capital of nearly $8,000,000. Its profits available for dividends have increased in a rapid ratio. They were as follows: 1914, $477,000; 1915, $1,490,000; 1916, $3,700,000.

The smaller chemical companies in France which have rapidly established plants for the production of coal tar and other organic compounds, all report most satisfactory financial results.

In England the report of "British Dyes, Limited," is a fair barometer for the results currently obtained by the group of firms engaged in the manufacture of artificial colors. The capital is nominally about $10,000,000, although not yet all paid up. A large part is furnished by the British Government. After paying the interest on such advances, and making generous provision for sinking fund and new plant, a sum of $75,000 remained, which sufficed to pay a dividend of 6% on paid-up stock and to carry $20,000 to the current year's account.

While the figures for "British dyes" are exceedingly modest as compared with profits on the continent, there is every reason to believe that the color industry in England is thriving and is occupied rather with laying the foundations for the future than in seeking large, immediate gains.

And the steady, businesslike pursuit of this policy will surely furnish its own rewards later on.

Artificial Dyestuffs in Italy

Like other countries, Italy is studying the problem of creating a national coal tar color industry. The obstacles to be overcome are much more serious than in any other large European country, on account of the absence of coal in the Kingdom and the lack of development in the chemical industry as a whole. There is, on the contrary, a rather large demand normally for dyestuffs and a growing desire to be independent of German sources in the future.

Dr. A. Bolis, in a recent number of "L'Industria Tessile e Tintoria," analyzes the situation quite fully. He emphasizes the necessity of adequate tariff protection, showing numerous anomalies in the present schedule of duties. Thus the duties, per 100 kilos, on benzine and toluene are $4.75; on most intermediates, $2.00; on benzaldehyde, $60.00. Aniline, toludines and finished colors are free of duty.

His conclusions are as follows:

1. Raw material must be exempted from an entrance tariff, while the intermediate and finished products should be charged entrance tariffs, higher in the latter case than the former.

2. The entrance tariff should be regulated in accordance with the fineness or quality of the products and with the number of the manipulations necessary for their manufacture.

3. The customs tariff should be more rationally arranged and be more detailed. No customs entrance tariff will be an assistance to the industry unless the fiscal arrangements are modernized with a view to the present necessities of the countury.

The necessity for this scientific and well-balanced protection he advocates in another paragraph:

"To be able to exist and prosper, the industry of synthetic coloring matters must have more than a hand-to-mouth existence; it must find itself in conditions of real prosperity. An essential factor is its continual development; it should be progressive and inevitable, founded on a rigorously scientific basis and requiring an incessant study of every element of progress and of every possible improvement. The industry to have a chance of life must show good balance-sheets; if the large German works had not made large profits, they could never have developed their admirable technical and scientific organization, and without this it would have been impossible for them to survive and prosper continuously."

Dr. Bolis looks forward to an intense competitive struggle, at the close of the war, in the effort to control the trade in synthetic dyes. His remarks in this connection, coming from one quite closely in touch with existing conditions, are worthy of careful reading, especially as they bear upon the

(*Concluded on page* 196)

THE COST OF CREATING A MERCHANT MARINE

By JOHN PRICE JONES

Two billion dollars for a new merchant marine is the grimly determined reply of the United States to the U-boat ravages of the German war autocracy. Although the Hun has torpedoed to ocean bottom nearly 8,000,000 gross tons of shipping flying the various flags of the Allies, America, unafraid and defiant, has consecrated this mighty sum to the resurrection and rehabilitation of the power represented by these sea-buried messengers of commerce. Systematized Liberty Loan campaigns are the great forces that insure the aggressive rebuilding that is now a critical necessity.

There was time when $2,000,000,000 would have seemed a sum too staggering for even intense patriotism to appropriate. Nothing is too costly that is dedicated to the preservation of freedom, but sentiment alone cannot carry on wars. To replace a vanished 8,000,000 tonnage requires immediately vast sums and vaster sums in addition to expand the shipping of the United States to meet the demands of trade after this great conflict has ceased. The coming third issue of Liberty Loan bonds points the way that this patriotic desideratum, thus far so nobly advanced, shall be carried on to glorious fruition.

It was in the Urgent Deficiencies Appropriation Act of June 15, 1917, that the determined purpose of the Government to replace its vanished shipping and prepare for a top-notch place in the struggle for commercial supremacy after the war, was made manifest. An item was included—it seems droll to call it such but so it has been legislatively designated—an item authorizing the purchase, requisitioning and acquisition of ships, materials, plants and charters on ships. This item was for the sum of $250,000,000—a fairly good intimation to the torpedo sea-assassins of Germany that Uncle Sam intends doing things.

And along a little further in the act came another item of $500,000,000 for the construction of ships, making the total appropriation for the new merchant marine at this one time three-quarters of a billion of dollars. It was a momentous day in American appropriative history. It marked a new Declaration of Marine Independence for the United States of America. The editors of Hun propaganda across the water took immediate notice. Their attempts to belittle the importance of the event only revealed the more their secret apprehensions.

Again, on August 3, 1917, the United States Emergency Fleet Corporation gathered to its control every vessel then building in the shipyards of the entire country, of 2,500 or more tons deadweight carrying capacity. Automatically above 400 vessels in various stages of construction were taken over. They aggregated more than 2,800,000 deadweight total tonnage. It was another forceful defi to Kaiserdom and Junkerism. Immediately construction went ahead at full speed with every hour of overtime in the work that could be crowded into the twenty-four of the work day. The echoes of the rivet hammers were heard in pounding rivalry to the malevolent work of the U-boat makers at the German sea-murder base.

To reimburse the owners of these vessels so taken, the sum of $265,000,000 was needed additional to the amounts already appropriated. This was authorized by subsequent legislation. It was forthcoming through the patriotic outpouring of Liberty Loan money by the free men and women of America.

To this magnificent initiative in the genesis of the United States merchant marine in this world war epoch, the Shipping Board made available a total of $550,000,000. This, too, Liberty Loan money put to its most effective use in an urgent hour. Up to September 22, 1917, by this authorization, contracts had been let for the construction of 636 ships with a total tonnage of 3,124,700. There will be 353 wooden ships, 225 of steel and 58 composite. The ratio of the Kaiser's recent U-boating to this mighty new commercial fleet is small almost to the point of negligibility.

Lastly in the way of cost of America's new merchant marine, legislation was introduced authorizing an additional $734,000,000 for new ship construction. There can be small doubt that the establishment of new tonnage in accordance with this mighty sum's possibilities, sounds the death knell of Germany's dreams of ocean trade supremacy. This sum will pay for the building of more than 8,000,000 tons deadweight in ships utilizable for trans-sea service. This means 5,000,000 tons in addition to the 3,000,000 now under construction and for which contracts have been let. Summarized as to effectiveness aside from cost, this is Uncle Sam's merchant marine challenge:

Ships under construction, requisitioned August 3, 1917—an aggregate of 400 of 2,800,000 deadweight tonnage.

Ships contracted for under the program for new

(*Concluded on page* 196)

INDUSTRY IN WAR TIMES

An Unofficial Statement Regarding "Essentials" and "Non-Essentials"

By

GEORGE N. PEEK

Realizing the confusion which existed in the minds of countless manufacturers throughout the country as to the exact interpretation of the terms "essential" and "non-essential" as applied to the various industries, and being further aware of the unsettled and therefore harmful conditions which must necessarily obtain until some of the doubts regarding the probable future attitude of the Government toward certain industries could be set at rest, Mr. Waddill Catchings, chairman of the War Committee of the U. S. Chamber of Commerce, recently wrote to Industrial Representative George N. Peek, of the War Industries Board, Council of National Defense, asking him for an unofficial view of the matter in the absence of a definitely formulated policy.

Mr. Peek's reply, in part, follows:

"The enclosed statement 'Industry in War Times, or Essentials and Non-Essentials' reflects my views on this subject and the view of a number of my associates with whom I have discussed the matter at frequent intervals during the past two months.

"You understand that this is entirely unofficial and must be so regarded, but it occurs to me that it may be of some help to you in answering inquiries as to the attitude of some of the men in Washington upon this most important subject.

"My observation leads me to conclude that the various Governmental departments are giving the subject careful consideration in the hope that by carefully and considerately treating the whole subject confusion may be avoided."

Although not directly relating to the chemical industries of the country, the statement appended to Mr. Peek's letter has been deemed of sufficient interest to a large proportion of the readers of the Chemical Engineer to warrant its reproduction in this journal, and it is accordingly here given in full:

Mr. Peek's Statement.

Industrially, the first problem of the Government is to secure the necessary supplies for the conduct of the war without too seriously interfering with the production of necessities for the public welfare. The second problem is to insure continuance of our industrial strength after the war.

Shortages of many classes of raw materials and of labor in different lines are evident. Transportation, both water and rail, is obviously short, and the need of industrial readjustment is apparent to make room for the war requirements of our Government and our Allies.

These problems may be solved by making provision for the entire requirements of the Government in such a manner as to utilize to the fullest extent present productive capacity. In many cases the facilities of less essential industries should be converted to essential production.

Limitation of Non-War Industries.

The discussion of the "limitation of 'non-essential' industries" started with a very unfortunate misuse of words. The idea, as exploited in the newspapers, that the Government intended to cut off "non-essential" industries, had in it possibilities for disaster.

All industries are closely inter-related. For instance, certain so-called "non-essentials" may be sent to South America to pay for commodities absolutely needed for essential products and no large class can be arbitrarily cut off without seriously affecting general business conditions in the country. Certainly no industry is "non-essential" to the workmen and capital employed therein, and when one considers that over ten million people and thirty billion dollars of capital are employed by "non-war" industries the need of caution in dealing with this problem is manifest.

On the other hand, our industrial equipment is limited. We do not have materials, machinery, transportation, labor or capital sufficient for fighting the great war and for normal business at the same time. The war must be prosecuted to the utmost and business must shrink to provide the necessary equipment with the least possible injury to the business of the country.

The first consideration of the Nation and all of its industries must be to contribute the utmost toward winning the war, and to that end business must, where necessary, be diverted from its established channels into new channels; or if absolutely necessary, the flow must, during the war, be entirely stopped in order to provide adequate labor and material for war needs. It does not, however, follow that there will be less business than usual, but rather more unusual business.

If the so-called "non-essential" industries are "cut off" many of them would be ruined and others permanently crippled.

The Fuel Administration has worked out a plan which provides, in part at least, for necessary restrictions with the least possible injury to industries. This plan provides for fuel curtailment by the following steps:

1. **Voluntary agreement** by each non-war industry to limit the least essential parts of its product—each industry making the reduction where it will do the least harm.
2. **Formal order** from Fuel Administrator making legal and binding on the entire industry the various restrictions voluntarily agreed upon.

This plan applies directly to actual fuel consumption only. The actual effect is to limit production. Consequently, limitation in the use of fuel will make a corresponding saving in transportation and in the materials needed for the war. The fuel saved will vary according to the character of each industry.

The above plan has already been tried out enough to prove its practicability. In each case the industry has given its heartiest support and shown its desire to co-operate with the Government in every possible manner. The voluntary saving shown by the industries already called into conference promises to be 15 million tons of coal. The brewers have voluntarily agreed to save 700,000 tons of coal; the box board manufacturers will cut their running time to five days a week. This will save one million tons of coal and take 30,000 cars of merchandise off the railroads.

The Commercial Economy Board of the Council of National Defense has undertaken to co-operate with business men in eliminating, as the Government's requirements demand, needless uses of men, materials, equipment, and capital in all lines of commercial business; in other words, to conserve commercial resources as necessary to meet the Government's need.

The Board's policy is to work forehandedly. It investigates forthcoming supplies and demands, to see where shortage is threatened; then introduces such economies as will prevent the shortage, or keep it from becoming needlessly acute.

Co-operation of business men with the Board is voluntary. The Board can not compel adherence to its recommendations by legal process. In fact, its purpose is to make such compulsion unnecessary. It works on the theory that there are considerable needless uses of labor, materials, equipment, and capital in all businesses, and that by forehand action and with voluntary co-operation from business men enough of these uses can in most cases be eliminated to meet Government requirements without resorting to more drastic methods.

Of course, there are certain commercial and industrial resources which can not be handled adequately for the Government's purpose in this way. In urgent cases these resources must be diverted quickly from the less essential to the more essential uses, in whatever manner seems most effective. But in most instances, at least for the present, the voluntary methods described would seem to be sufficient.

The Board is now carrying on campaigns for conservation in several industries, including the manufacture and distribution of wool and woolen clothing, leather and shoes, and paint and varnish, and in the service of wholesale and retail stores. The Board is also making preliminary studies of other commodities in which, because of shipping or other conditions, there is a possibility of shortage.

Coal Production.

On acount of transportation conditions, the United States, according to the Fuel Administration, will probably mine little if any more coal in 1918 than in 1917.

1916 coal production approximately 575,000,000 tons.
1917 coal production approximately 630,000,000 tons.
1918 coal production estimated not to exceed 630,000,000 tons.

War industries and railroads must have at least 100,000 tons per day more than they had in 1917, or the flow of war necessities will be dangerously interrupted. This increase must be met by curtailment of the so-called "non-essential" production and by economy at every furnace door, both household and industrial.

The demands for 1918 to carry out the program for the production of necessities for the war, in addition to the normal business, would greatly exceed any possible production and distribution of fuel, so there is but one remedy, i. e., to limit the production of non-war industries sufficiently to provide for:

(a) War needs—direct and indirect.
(b) Necessities for the public welfare and domestic consumption.

In accomplishing the desired end, it should be our effort to divert the energies of non-war industries as far as possible to the production of the essentials for war, that each industrial center may use existing facilities, with its labor living at home, happy and contended.

In the readjustment process it is inevitable that the normal business of some industries must be interfered with in order that the production of war and public necessities be kept at the maximum. It may be that some plants, because of lack of power, shortage of labor, raw materials, or transportation, may have to suspend entirely. These sacrifices must be endured in the interest of our first object, which is to win the war. If we secure complete co-operation between Government and business, it is hoped that our industries may emerge from the disturbed condition caused by the war, intact and strong for the economic problems which must face us.

Duty of War Industries Board.

It would seem to be the immediate duty of the War Industries Board—

1st: To list, by classes or otherwise, and to define those industries whose operation as a war measure are of **exceptional importance,** classifying them as far as practicable in the order of their relative urgency, measured by the extent of their contribution, directly or indirectly, toward winning the war.
2nd: To consider carefully and, after due notice

(*Concluded on page* 196)

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By CARLETON ELLIS and A. A. WELLS.*

PART XII

Keyes' Apparatus.

An apparatus for treating oils, milk or other substances which are not transparent to them, with ultra violet rays, is disclosed by *Keyes* (U. S. Pat. 1,235,698, Aug. 7, 1917). The liquid to be treated is fed from the top of the apparatus (See *Figure* 1) and allowed to flow down over the screen in thin layers, where it is exposed to the light and is collected in a trough in the bottom. The screen may be made of metal or of fibrous material, depending on the character of the liquid being treated.

Heyl (Chem. Abs., 1918, 103; Dan. Patent, 22,258 and 22,269, July 16, 1917) proposes to dry waxed leather by exposing it to the action of ultra violet rays in the presence of ammonia derivatives, hydrazine or nitrogen.

Celluloid Substitutes.

Details of the production of useful products by the polymerization of vinyl esters when employing the mercury vapor lamp or other source of light are given by *Klatte* and *Rollett* (U. S. Patent 1,241,738, Oct. 2, 1917. Chemische Fabrik Greisheim-Elektron). The polymerization can be accelerated by catalyzers, benzoyl peroxide, oxonides, and anhydrides of organic acids in conjunction with an agent giving off oxygen (perborates, percarbonates, silver oxide, etc.) being mentioned for the purpose. The polymerization products, which form more or less rapidly in accordance with the intensity of illumination and the temperature, are solid, colorless and transparent celluloid-like masses which are odorless and can be turned, cut, planed, and otherwise manipulated to form various articles. The solid masses obtained can be rendered plastic in hot water and then be molded and, after cooling, the mass becomes again hard. In order to obtain special effects the initial materials may be mixed, prior to exposure to light, with other bodies or conditioning agents, such, for instance, as camphor or coloring matters.

Chlorinated esters may be polymerized by heat and light as a two-stage operation in the following manner: 1 kilogram of vinyl chlor-acetate is mixed with from 0.5 to 1 gram peroxide of benzoyl and carefully heated in a large vessel provided with a reflux condenser. At from 80° to 100° polymerization takes place, while the temperature rises rapidly. At this time care should be taken to cool the reaction vessel. The violence of the reaction may be modified by diluting the reaction liquid with an indifferent solvent; for instance, in the present example, about 300 grams of chloro-benzine can be used. The reaction product is a viscous syrupy mass, which can be further treated by exposing to light without a diluent, solid masses being obtained as the remaining unaltered vinyl ester polymerizes. The syrupy solution or a solution made from the completely polymerized ester may be used as a lacquer or other coating compound. When allowed to dry in thin layers, colorless films of a celluloid-like nature are obtained. Vinyl chloride may be polymerized by ultra violet rays, but the product derived is not as satisfactory as that obtained from the esters mentioned.

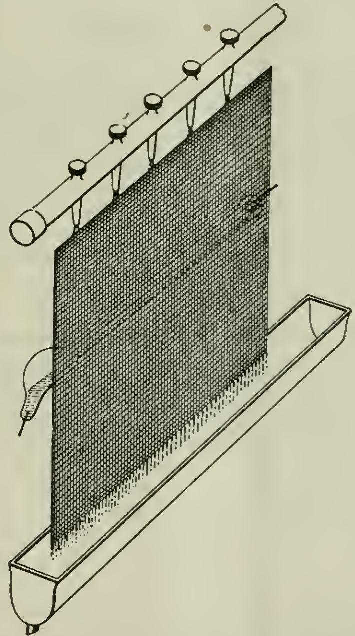


Fig. 1—Keyes' apparatus for the exposure of opaque liquids to ultra violet rays.

Preparation of Catalyzers.

A process for activating catalysts for use in hydrogenating unsaturated fatty acids and their glycerides is described by *Utescher* (U. S. Pat. 1,124,560, Jan. 12, 1915). The metal to be used as a catalyzer is treated with hydrogen and at the same time exposed to the action of the rays from a mercury vapor lamp or to a silent electric discharge. It is claimed that by this treatment the metal is atomized and made very active.

---

*All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

Spent catalyzer is claimed to be revivified by being treated in this manner after the fat has been burned out.

Chlorination of Natural Gas.

The chlorination of natural petroleum gas under the influence of the rays of a mercury lamp has been investigated by *Tolloczko* (Chem. Abs. 1914, 1282; Abhandl. Krakauer Akad. Wissensch., 52, 307-16; Chem. Zentr., 1913, II, 99-100). The chlorination was carried out in the outer coat of an ultra violet lamp set up in the form of a Liebig condenser. No explosions resulted, even when the proportions of chlorine and natural gas were the same. The temperature varied between 80° and 100°. In the chlorination with an excess of the natural gas (natural gas: chlorine=1 : 2) the velocity of the gas stream was 4 liters per hour. A yield of 1.18 grams oily and 0.24 grams gaseous products was obtained per liter of gas. With a double passage of the gas through the walls of the ultra violet lamp these yields increased to 1.53 grams oily and 0.38 grams gaseous products per liter. The volatile portion consisted chiefly of methyl chloride and dichlor methane. By fractional distillation the oily products were separated chiefly into dichlor methane, carbon tetrachloride, dichlorethane and tetrachlorethane. In chlorination with an excess of chlorine an oily product and solid hexachlorethane were obtained.

Chlorination of Hexane and Heptane.

Graul and *Hanschke* (U. S. Patent 1,032,822, July 16, 1912) produce halogenated paraffin hydrocarbons by mixing the hydracarbon with chlorine in the dark and then exposing the mixture to ultra violet light. Directions are given for making chlorhexane and heptane as follows: Normal hexane is boiled in an enameled vessel, on the water-bath, and the vapors pass through a vertical fractionating column into a second vessel into which chlorine is led at the same time and in which the mixture of the components takes place. The mixture containing an excess of hexane vapor passes into a third vessel in the middle of which a mercury lamp is burning. The vapors leaving this reaction vessel are passed through a condenser in which the chlorhexane and the excess of hexane condense and pass through a siphon into the distillation vessel, while the hydrochloric acid formed during the process is allowed to escape from the circuit. The fractionating column attached to the first vessel is maintained at such a temperature that only hexane is allowed to pass, while chlorhexene remains in the distill-vessel and increases in quantity. To prepare monochloriso heptane, Galician petroleum of B. P. 88-92°C. is purified as far as possible by repeated distillation and extraction with sulfuric acid, affording a fraction which consists chiefly of isoheptane. This is placed in a lead lined vessel provided with fractionating column and raised to the boiling point, at a pressure of 50 mm. of mercury. The vapors are mixed with chlorine and passed through a vessel containing a mercury lamp, whereupon chlorination takes place. In order to chlorinate 10 parts of hydro-carbon, about 7 parts of chlorine are necessary. The chlorination product consists chiefly of a monochlorisoheptane which boils at about 140° C. and contains, according to analysis, 26.5% of chlorine. By treating, in a similar manner, the repeatedly purified fraction of Galician petroleum which boils at from 75° to 81° C., a product is obtained boiling between 135° and 145° C., and containing 29.1% of chlorine, while pure monochlorhexamethylene contains theoretically 29.8% of chlorine.

In the writers' laboratory, a number of experiments have been made to compare the production of benzyl chloride, benzal chloride and benzo trichloride by the chlorination of toluol under various conditions. The best results were obtained by passing an excess of toluol vapors mixed with chlorine through a transparent quartz tube while exposing to the action of the ultra violet light. The product was withdrawn from the reaction tube and the contents were collected and fractionated, the unused toluol being returned through the reaction tube. In order to determine the effect of the ultra violet rays on this reaction the source of light was removed and the experiment carried out in the same manner as described above. The results of one test are given in the accompanying table.

Fraction	Quartz Tube without U. V. Light	Quartz Tube With U. V. Light
A. Up to 150°C.	72%	42
B. 150- 170°C.	4.2%	2
C. 170- 185°C.	18.5%	47.5
D. 185- 215°C.	3.8%	6.5

Sterilization of Water.

A description of the plant and operation of a large pressure type ultra violet water sterilizer at Henderson, Kentucky is furnished by *Smith* (Engineering News Record 1917, 1021). The water delivered to the sterilizer is first passed through settling and coagulating tanks then through mechanical filters before reaching the sterilizer. The source of water supply is the Ohio river; the raw water is pumped into two coagulating basins 95 ft. long, 30 ft. wide and 16 ft. deep, where it is stored for 4 hours, then into two baffled mixing chambers 25 ft. long, 7½ ft. wide and 17½ ft. deep, and from there into six reinforced concrete filter units 17 ft. long and 13 ft. 4 in. wide with a normal capacity of 625,000 gallons each per day. The ultra violet sterilizers consist of three legs each, (Fig. 2,) comprising five units. The legs are connected in parallel and the entire equipment is connected in series with the pipe line leading from the filtered water basin to the storage for the city supply. Each unit has a lamp box inserted in the side equipped with a clear quartz closed end tube which projects into the body of the unit and around which the water is forced in a thin film by means of a baffle placed at 90° to the long axis of the sterilizer. The quartz tube is contained in a slotted opening in the baffle. The lamp proper is a 220 volt direct current mercury vapor arc lamp and is designed to be automatically tilted by a special support located in the lamp box. The individual lamps are so connected that they may be adjusted individually and are also connected to the main switch board, each lamp having a "tell tale" incandescent lamp and a warning bell to notify the operator in case any of the lamps are not functioning properly. The following table shows the efficiency of the installation on which daily tests were made for over two months:

TYPICAL RESULTS, BACTERIAL TESTS AT HENDERSON WATER-PURIFICATION PLANT.

Sample	Total No. of Samples	Bacteria per c.c., 24-hr. Incubation — Total Bacteriar — Maximum	Average	B. Coli — Maximum	Average
Raw	25	190,000	85,000	1000.0	276.0
Coagulated	25	1,200	820	100.0	45.0
Filter	70	320	80	1.0	0.35
Leg 1:					
Influent	52	95	32	1.0	0.260
Burner 1	48	30	16	0.8	0.215
Burner 2	48	20	8	0.8	0.200
Burner 3	48	16	6	0.2	0.136
Burner 4	48	6	2.10	0.1	0.090
Burner 5	54	3	0.31	0.0	0.000
Leg 2:					
Influent	53	75	36	1.0	0.310
Burner 1	47	50	12	0.6	0.273
Burner 2	47	20	6	0.8	0.18
Burner 3	47	7	5.20	0.4	0.117
Burner 4	47	6	1.80	0.1	0.07
Burner 5	54	3	0.38	0.0	0.0
Leg 3:					
Influent	54	95	25	1.0	0.326
Burner 1	47	55	14	0.8	0.240
Burner 2	47	19	9	0.8	0.21
Burner 3	47	12	4	0.4	0.110
Burner 4	47	6	1.60	0.1	0.06
Burner 5	54	3	0.42	0.0	0.0
Tap at pumps	34	11	0.39	0.0	0.0

Rate of pumping 2,200,000 gal. per day to 3,200,000 gal. per day, with little or no variation in results.

Turbidity of raw water varied from 130 to 880 r.p.m.

Filtered water usually clear with maximum turbidity of 5 r.p.m.

The rate of pumping was 2,200,000 to 3,200,000 gallons per day with little or no variation in results. The turbidity of the raw water varied from 130 to 880 p.p.m. The filtered water was usually clear with a maximum turbidity of 5 p.p.m. The plant has been operating for some months under a varying capacity of from 2,200,000 to 3,500,000 gallons per day at an expenditure of 92.5 kilowat hours per million gallons.

Mason (Water Supply, page 202, published by John Wiley & Sons, 1916) shows a type of ultra violet installation for sterilizing water on a large scale. The efficiency of this type of apparatus as compared with other methods of sterilization is given. It is concluded that in case the water is clear (not turbid) it may be efficiently sterilized by this method and that the color of the water is not a serious hindrance to proper sterilization, but that turbidity, whether caused by organic or inorganic material, diminishes the sterilization. It is also stated that a rather high velocity of the water passing through the sterilizer is preferable as agitation is beneficial for securing high sterilizing efficiency.

Newcomer (J. Exp. Med., 1917, 841-8) in discussing the abiotic action of ultra violet light states that typhoid bacilli are about 1/200 as sensitive to ultra violet light of wave lengths 2100-2800 Angstrom units as is the photographic plate. Their sensitivity to longer waves decreases rapidly to almost zero at about 2970.

Transparency of Media.

The absorption of ultra violet light has been discussed by *Luckiesh* (Met. & Chem. Eng., 1918, 232). The spectrum is divided somewhat arbitrarily into four regions as follows: Visible spectrum extends to wave lengths slightly shorter than 400 $\mu\mu$; near ultra violet. 400 to 300 $\mu\mu$; middle ultra violet, 300 to 200 $\mu\mu$ and the Schumann region, 200 to beyond 100 $\mu\mu$. The transparency of various substances to light waves of short length may be summed up as follows:

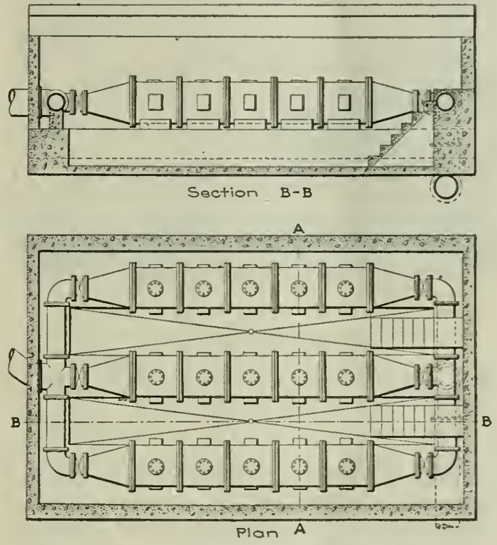


Fig. 2—How the municipal water-sterilization plant at Henderson, Ky., was laid out, showing the three parallel five-unit legs. (Courtesy R. U. V. Co., Inc., N. Y.)

Ordinarily clear glass is quite transparent down to 350 $\mu\mu$, but is practically opaque at about 300 $\mu\mu$. Special glasses have been made, however, which are transparent as low as 185 $\mu\mu$. For example, glass composed of 6 parts calcium fluoride melted with 14 parts of boric anhydride is recommended. Fused quartz is transparent as low as 180 $\mu\mu$. Fluorspar is transparent to 120 $\mu\mu$, but as the atmosphere absorbs these short rays very readily it is necessary when using such rays to take special precaution against absorption. Gypsum, celestite, borite, sugar crystals, calcite, and alum are transparent to about 170 $\mu\mu$. Rock salt is transparent to 185 $\mu\mu$. Mica and gelatine absorb the very short waves and therefore cannot be used when working below about 200 $\mu\mu$.

As it is sometimes desired to work with waves of restricted length, various substances may be used either singly or in combination, so that all but the desired waves may be absorbed. For example, copper sulphate, methy violet, chlorine, bromine, alkali metals dissolved in ammonia and various other substances may be used in solution in cells or mixed with gelatine and coated on plates. According to Luckiesh, Absalom (Phil. Mag. 1917, *33*, 452) gives the following table showing the wave lengths which are completely absorbed by certain substances.

Natural blue rock salt	Beyond 225 μμ
Natural rock salt colored by cathode rays	Beyond 225 μμ
Natural rock salt colored blue by cathode rays	Beyond 225 μμ
Sylvite, white	Beyond 225 μμ
Chili saltpetre, ordinary white variety	351.2 μμ
Chili saltpetre, violet	324.8 μμ
Fluorspar, colored deep violet by cathode rays	Beyond 225 μμ
Diamond yellow	320 μμ
Diamond blue	315 μμ
Kunzite	305 μμ
Garnet	402.3 μμ
Zircon (hyacinth) red-brown	261.8 μμ
Zircon, decolorized by heat	244.2 μμ
Zircon, green	402.3 μμ
Zircon, yellow	402.3 μμ
Topaz, pale yellow	261.8 μμ
Topaz, dark yellow	229.4 μμ
Topaz, pale pink-brown	261.8 μμ
Topaz, blue	296.1 μμ
Emerald	320 μμ
Ruby	300 μμ
Tourmaline, green	351.2 μμ
Tourmaline, green-yellow	300 μμ
Tourmaline, pink	306.4 μμ
Spinel, blue	402.3 μμ
Spinel, purple	324.8 μμ
Spinel, pink	300 μμ
Kyanite, blue	320 μμ
Beryle, blue	327.4 μμ
Cordierite, blue-purple	324.8 μμ
Cairngorm	324.8 μμ

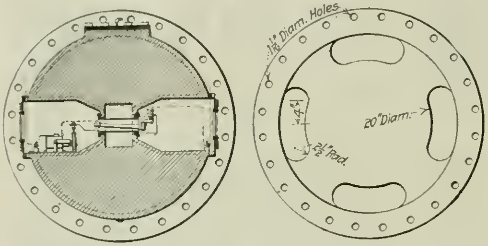


Fig. 3—Section through ultra violet unit, showing elevation of baffle.
(Courtesy R. U. V. Co., Inc., N. Y.)

Liveing and *Dewar* (Proc. Royal Society, London 1883, 71) have made measurements of the wave lengths absorbed by various substances. The source of light was an iron arc in most cases, although other electrodes were used. A spectroscope having quartz lenses was used for making the operations. Gases were enclosed in tubes which had either quartz or rock salt plates at the ends and liquids were placed in cells having quartz sides. Chlorine, bromine, iodine, hydrogen sulphide, carbon trisulphide, carbon tetrachloride, chlorine peroxide, chrome alum, mica, silver, gold and iceland spar were examined and the wave lengths absorbed given. The lines of absorption vary with the density of the solution, varying from 2500 to 4000 Angstrom units with the greatest proportion lying between 3000 and 3500.

Kron (Ann. Physik. *45*, 377-98, 1915) discusses numerous measurements of the limits of ultra violet solar radiation recorded at various distances to determine the degree of extinction of such radiation by the atmosphere. The limit of effective rays is near 3250.

If photographic methods which exclude visible light rays were applied to various physical phenomena, *Wood* (Smithsonian Institute 1911, 155) states that new facts would probably be discovered. In order to accomplish this exclusion, suitable screens must be employed. Glass lenses cut off invisible rays, while quartz lenses coated with metallic silver cut off visible rays, but allow the invisible rays to pass. Dense cobalt blue cells filled with a solution of potassium bichromate make possible photographs in infra red rays. Infra red rays are not scattered by the atmosphere, while ultra violet rays are so scattered that it is unlikely that any of them reach us from the sun, but that such rays as do reach the earth come from the sky; uranium nitrate shines when exposed to ultra violet rays, while vapors of mercury may be seen rising from a body of mercury even at room temperature when photographed in ultra violet light.

Sterilization and Absorption.

In the experiments of *Browning* and *Russ* (J. S. C. I.; 1917, 1146; Proc. Roy. Soc., 1917, 33-38; Chem. Abs. 1918, 187.) a tungsten lamp and a quartz spectometer, giving wave lengths of 7000-2100 Angstrum units, were used. A glass plate coated with nutrient agar was painted with an emulsion of Staphylococcus pyrogenes aureus, and a narrow strip of the plate was exposed to the rays from the lamp for 6, 12, or 24 minutes. The plate was then incubated It was found that there was a germicidal action on that part of the strip exposed to rays of wave lengths 2940-238C units. The longer exposure only very slightly increased the range of germicidal action. Exposures of 3½ hours gave a sharp line of demarcation at 2960 units, the other limit being 2150 units. Plates of Bacillus coli communis, B. typhosus, acid fast bacillus (timothy grass B) and meningococcus were also exposed to the rays, and the range of action was found to be nearly the same, although there were small and definite differences in each case. Emulsions of the organisms were also exposed to the rays and photographs of the radiations transmitted were taken. It was found that absorption of the rays took place over the same range that gave the germicidal action. Rays with wave lengths between 3800 and 2960 A. had no marked germicidal action, but were able to penetrate a considerable thickness of human skin. Rays with wave lengths from 2960 to almost 2100 A. had a very marked germicidal action, the maximum effect being obtained between 2800 and 2540 A. These rays however, possess but little penetrating power, being completely absorbed by as little as 0.1 mm of human skin.

Visible light rays are not as a rule absorbed by protoplasm is the conclusion of *Harris* and *Hoyt* (Univ. Cal. Science, 1917, 818-20); hence their action is usually confined to specialized pigment areas which constitute the receptive elements of optical sense organs. Ultra violet light is generally highly toxic even for colorless organism, and since this toxicity probably depends upon photochemical reactions the question raised is, to which constituent of the protoplasm is to be attributed the selective absorption of these rays and which is the necessary precedent to their photochemical activity? Experiments were made to determine the time in seconds of exposure to the direct rays of a Cooper-Hewitt ultra violet light, type Z, at a distance of 12 centimeters from the quartz tube. It was proved that the normal extermination period for washed paramecia suspended in water was about 100 seconds and that the organisms were not affected by the gases, ozone and nitric oxide, formed during 100 seconds of exposure when the light was cut off. Average extermination periods for paramecia in 1% suspensions of cane sugar, urea, alanine, leucine, gelatin, and peptone were determined, and for the last three were 215, 220 and 300 seconds respectively, while the first three gave results only slightly higher than those for water. Glutamic, aminobenzoic and aspartic acids were each toxic for the organisms and could not be used directly. Tyrosine, though very sparingly soluble in water, in saturated solution was decidedly protective and lengthened the extermination period to 180 seconds. Alkaline solutions were toxic. In order to test these toxic solutions the paramecia were placed in a flat watch glass, covered with a card having a circular hole into which a quartz beaker containing the test solution fitted. Solutions cystine and tyrosine were made by adding a slight amount of caustic soda. The results showed that solutions of aminobenzoic acid, cystine, tyrosine and leucine detoxicated ultra violet rays which pass through them. The protective action of tyrosine in alkali solution was especially marked; 1% tyrosine in 0.2% caustic soda perfectly screened the organisms during 40 minutes of exposure. The action of leucine, which does not exhibit selective absorption for ultra violet light, was attributed to a chemical change in the leucine solution induced by exposure to the light yielding a substance having an increased power of absorbing ultra violet rays. This view is supported by the fact of a change of color in a leucine solution thus exposed. The results of this study "are in harmony with the view that the susceptibility of protoplasm to ultra violet light is conditioned by the selective absorption of the toxic rays by the aromatic amino acid radicals of the proteins."

Fig. 4—Exterior of Henderson water-works, which has combination filter and ultra violet sterilization.
(Courtesy R. U. V. Co., Inc., N. Y.)

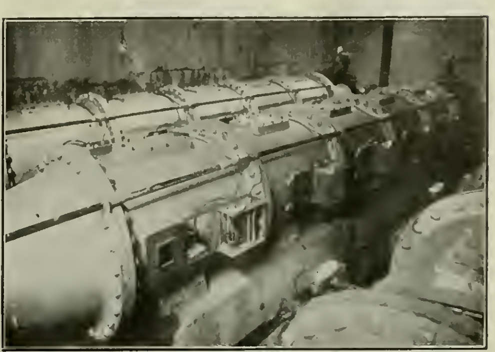


Fig. 5—Interior, ultra violet sterilization plant, of Henderson water-works.
(Courtesy R. U. V. Co., Inc., N. Y.)

Photographic Registration of Ultra Violet Spectra.

An apparatus for the quantitative photographic registration of ultra violet spectra has been devised by *Lankshear* (Chem. abs., 1917, 3133; Proc. Manchester Lit. Phil. Soc., 1915, 1-4). The optical part proper consists of two identical trains of quartz reflecting prisms and condensers focusing comparable beams from the same light source upon the slit of the quartz-prism spectrograph. In the path of one beam is placed the absorption vessel, in the path of the other a sector for quantitatively altering the comparison intensity. The sector is the novel feature, being designed to avoid intermittent illumination and the consequent photographic error. Instead of slots out near the periphery, as is usual, there is a single semi-circular hole the diameter of which passes through the center of the wheel. A disk having a corresponding hole in it can be rotated on the face of the sector wheel, thus altering the aperture of the sector. The latter is graduated logarithmically, because the measured quality is log (1/1°). In view of possible slight defects in the quartz condenser the sector can be rotated if necessary, either by hand or by clockwork. Details are given as to centering and adjustment. It is pointed out that the central sector acts by cutting down the beam, which nevertheless falls continuously on the photographic plate. While with the Hilger instrument the greatest length of fluid which can be used is 5 centimeters, with the new apparatus a Baly tube can be used, and with one solution the extinction coefficient over a wide range of the spectrum determined. Also, since the image is focused on the slit instead of on the object glass, an increased amount of light is obtained in the spectrograph.

Notes on Ultra Violet Lamps.

The mercury arc was first studied by Arons in 1892 and was developed commercially by Cooper-Hewitt in 1902. According to *Child* (Electrical Arc, VanNostrand, 1913, 87) the advantages claimed for the mercury arc as a source of light are that the rays are not emitted from a small space as in the ordinary arc, but they extend along a tube which is usually six or more inches in length and that the operation of lamp is very simple; there being no necessity for adjustment of the electrodes and no renewals. As long as the vacuum of the tube is intact the lamp is in adjustment for operation. The fact that mercury vapor loses its conductivity very rapidly when the lamp is extinguished makes the use of the alternating current impossible, a direct current being necessary for satisfactory operation.

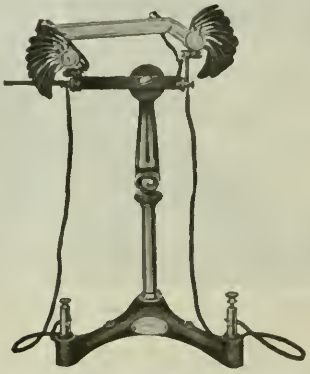


Fig. 6—Heraeus quartz mercury vapor lamp for direct current. (Note copper "fins" for heat radiation.)
(Courtesy Hanovia Chem. Mfg. Co., Newark, N. J.)

The Heraeus quartz mercury vapor lamp (see Fig. 6) consists of three essential parts: the quartz tube through which the arc plays, an anode receptacle and a cathode receptacle. The current is carried to the lamp through nickel rods ground into the side tubes of the electrode receptacles, the joints being sealed with mercury. The mercury chambers are kept at a somewhat lower temperature than the remaining portion of the lamp by means of fins made of copper, which serve to radiate heat rapidly. The quartz lamp proper is supported upon a stand and after being put in operation by tilting may be burned either in a horizontal or vertical position. The lamp is made to burn on either 110 or 220 volt circuits and it is claimed that the efficiency is substantially the same in either case. Figure 8 is a photograph of the spectrum of the Heraeus lamp, which gives an idea of the richness of the rays in the ultra violet region; this is shown by the length of the spectrum falling to the left of line 3900 Angstrom units, which portion of the spectrum is not visible to the eye.

The Heraeus vapor lamp is also made for alternating current, the difference in construction being that for this current it is necessary that there be two positive electrodes in place of the one ordinarily used for direct current. (See *Fig. 7.*)

A mercury vapor lamp manufactured by the General Electric Co., as described by Child (Electrical Arc, Van Nostrand, 1915), consists of a carbon anode and a mercury cathode. A fine carbon filament runs through the lamp and dips into an iron cup which floats on mercury in the bottom of a tube. As soon as the current is started the cup is drawn down by means of a solenoid, thus forming an arc at the bottom of the carbon filament, and as this is more resistant to the current than mercury vapor the arc rapidly extends through the whole length of the tube.

Sealing Wires in Quartz.

A method of sealing wires of molybdenum and molybdenum alloys gas-tight in quartz glass is proposed by Podszus (Chem. Abs. 1918, German Pat. 293,963, Mar. 15, 1914). A flux consisting of about ten parts silica, one part alumina and one part boric acid is suggested. The content of silica in the flux is increased towards the body of the quartz. The union is stated to be improved by the presence of a small amount of oxide on the surface of the metal or alloy, due to the solvent action of the flux for such oxides. For this purpose two parts of orthoclase may be added to the flux immediately surrounding the metal wire. Alkali earths produce the same results.

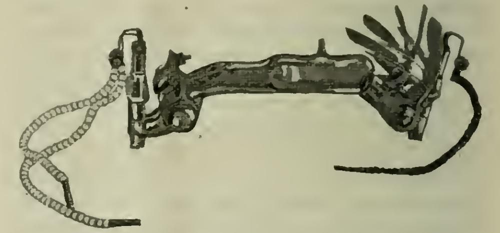


Fig. 7—Heraeus quartz mercury vapor lamp for alternating current.
(Courtesy Hanovia Chem. Mfg. Co., Newark, N. J.)

Luckiesh (*Met.* & Chem. Eng. 1918, *232*) refers to various sources of ultra violet light and discusses their uses. The ideal source of light is one which will give as near as possible a continuous spectrum through the desired region. But up to the present such a source has not been developed except within somewhat narrow limits. The sun emits a fairly continuous spectrum as low as $295\ \mu\mu$, but there are some dark lines due to selective absorption. The mercury arc has advantages of steadiness, but has some large gaps in the spectrum, and the ultra violet energy decreases in the case of old lamps. Some old quartz mercury arcs have been found only half as effective as they were when new. The ordinary carbon arc emits a considerable quantity of ultra violet rays in the near and middle regions. The magnetite arc has a positive pole of copper and a negative pole consisting of a sheet steel tube packed with a fine powder consisting principally of oxides of iron (magnetite), titanium, and chromium. This arc is fairly rich in ultra violet rays.

Rating of Different Sources.

Measured from the standpoint of total ultra violet energy per unit of visual intensity of illumination, Bell (Elec. World, Apr. 13, 1912) ranks these sources in the following order: magnetite arc, old mercury arc, new mercury arc, and carbon arc, the last two being about equal on this basis and more than twice as rich in ultra violet rays as the first two. This basis is of interest in lighting, but it should be noted that, in general, the ultra violet output per watt of energy input is generally of interest.

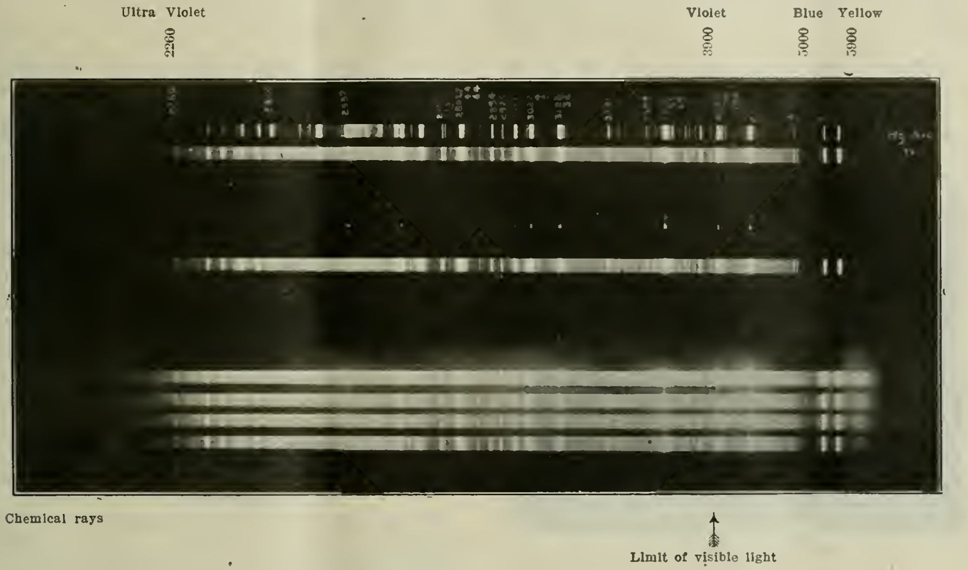


Fig. 8—Photograph of spectrum of Heraeus direct current mercury vapor lamp.

Lyman has shown that the mercury arc emits a strong line near 185 $\mu\mu$ which will be very effective, in some reactions, with a short air-path, but only feeble with a long air-path owing to the absorption by the air. This indicates that, when dealing with radiation of such short wave-lengths, very different results may be obtained with the same source, depending upon the distance of the reaction from the source.

The Flame Arc.

The flame arc has potential possibilities as a source of ultra violet rays owing to the diversity of materials with which the carbons may be impregnated. It has been found that the feebly luminous flame of the ordinary carbon arc is the source of much of the short-wave ultra violet energy emitted. The white-flame arc of high amperage, in proportion to the energy input, is the most efficient commercial source of near and middle ultra violet energy available at present. It radiates energy quite extensively in the near and middle regions. Obviously the blue flame arc emits ultra violet energy very strongly.

Construction of Iron Arc Apparatus.

It is a simple matter to construct an arc which will emit ultra violet energy strongly, provided hand-control is satisfactory. An iron rod and a carbon rod may be employed successfully for the two poles; however, two iron rods may answer the purpose very well. These poles may be kept cool effectively by means of heavy brass or copper sleeves which may be moved along the iron rods as the latter are consumed. A particularly successful iron arc of this type can be made very readily. The upper pole, which is negative, may be an iron rod about ¼-in. in diameter. This is surrounded by a movable but well-fitted solid sleeve of copper about one inch in diameter. The lower pole may be an iron rod about ½-inch in diameter with the end in the form of a shallow dish. One pole should be adjustable vertically. In preparing the arc a bead of molten metal is developed in the dished end of the lower electrode, the latter becoming oxidized, which apparently decreases the rapidity of deterioration. The upper electrode is well cooled and the arc is maintained very steadily between the molten bead of iron and the upper solid electrode. Luckiesch has had such an arc operate at a rather high current density for thirty minutes without any adjustment. The dimensions may be increased to meet the requirements. It is not a difficult matter to make various simple arcs which are quite satisfactory for a great deal of work.

Sparking Apparatus.

For many purposes, according to Luckiesch, the spark between metallic electrodes is very satisfactory but, in general, sparks can not compete with arcs in quantity of ultra violet energy emitted. Various forms of spark gaps have been employed depending upon the requirements; usually steadiness of position of the spark and shadows of the poles are the factors which determine the shape of the gap. A short spark obtained from a transformer may be satisfactory or it may be fattened by using a condenser. A high frequency spark may sometimes be desirable. The kind of spark obtained depends upon dimensions and electrical relations and obviously these may be widely varied. The metals commonly employed for the poles of spark gaps are aluminum, zinc, iron, copper, and cadmium, although any other may be satisfactory, depending upon its spectrum and upon the specific requirements.

Vacuum Tubes.

The spectra of electrically excited gases confined at low pressures in transparent tubes have been extensively studied, but Luckiesch states that such vacuum discharge tubes have found little or no use in industrial processes. They have provided sources of extreme value in some investigations. The spectrum of hydrogen under these conditions exhibits many lines and bands in the Schumann region. These tubes are usually of the capillary type and contain the gas at low pressures of the order of magnitude of one mm. of mercury. In order to be useful in the extreme short-wave region, they must be provided with a fluorite window.

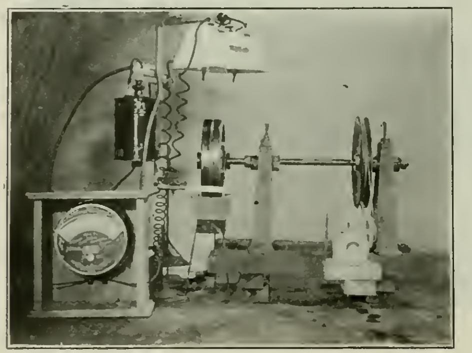


Fig. 15—Type of laboratory apparatus for exposure of oils to ultra violet rays.

Extraordinary Variations in Wave Lengths.

In discussing the subject of ultra violet light and the narrow limits of the length of the light waves which are active in sterilization and in aiding chemical reaction, it is interesting to make a comparison with the length of other waves with which we are familiar, viz.,—the colors of the spectrum, heat waves, sound waves, and electric waves.

The color spectrum ranges from .00065 mm. for red at one end of the visible spectrum to .00040 mm. for violet and .00012 mm. for extreme ultra violet, which is the lower limit of the metallic arc. The lower limit of the mercury spectrum is .00022 mm. while the wave length most efficient for sterilization is .00028 mm.

Wave lengths shorter than .00036 are scarcely visible to the human eye. The upper limit of the infra red rays as given off by a welsbach lamp is .60 mm. The wave length of heat waves at 0°C. is .0107 mm., a shrill whistle sends out waves 13 mm. long, middle C on a piano has a wave length of 1300 m., wireless telegraphic waves are in the neighborhood of 30500 mm., while the ordinary 60 cycle alternating field current has a wave length of 4,990 million mm. or 3,100 miles.

In order to illustrate these figures and put them in a form where we can get an idea of the comparative values of each, let us multiply them by the factor 10,000, which will give us in round numbers 1 mm. for extreme ultra violet, or, say the thickness of an ordinary pin, violet would then be twice the width of the pin head, red would be a quarter the length of the pin, heat waves at 0°C temperature would have a length of 4¼ inches, a shrill whistle would have a wave length of nearly one and one-half city blocks, while middle C on the piano would give off waves eight miles long. The shortest wireless telegraph wave would then be 190 miles long, or the distance from New York City to Albany, while the 60 cycle a.c. field current would be 31 million miles or one-third the distance from the earth to the sun. The limiting values of ultra violet wave lengths and their place in the domain of elastic fluid undulations is thus strikingly illustrated.

Dehydration.

The influence of light on the evolution of water of hydration from salts has been observed by *Beutel*, (Oesterr. Chem. Ztg. 19, 123-4; through Chem. Zentr. 1916, II, 638. Chem. Abs. 1918, 249), who observed that efflorescent spots appearing on crystals of chrome alum and of cobalt magnesium sulphate increased very rapidly on exposure to light In ultra violet light from a mercury arc the decrease in weight was nearly twice as great as in the dark.

Fig. 15 illustrates laboratory apparatus used in subjecting oils to the action of ultra violet light. A grooved pulley driven by a worm gear and motor connections causes a flat pulley to revolve in a pan of oil supported on a tripod. The ultra violet lamp is placed directly over the flat pulley and the oil is exposed thereto as a thin film. A spatula placed against the face of the pulley removes the insolated oil. On the left is shown a voltmeter and immediately above it, a rheostat controlling the flow of current to the lamp.

(To be continued in the April issue.)

Hawkes Now a General Chemical Co. Director.

A. W. Hawkes has been elected a director of the General Chemical Co. of New York to succeed John M. Goetchius, who has resigned to enter Government service.

The Eagle Paint & Varnish Co, Pittsburg, Pa., has just completed alterations and improvements to its plant to provide for increased capacity.

INORGANIC CHEMICAL SYNONYMS

A Novel Work of Reference for Student and Chemist

By

ELTON R. DARLING*

Although Intended Primarily for the Student, It Is Believed that the Following Compilation of the Various Terms Employed to Designate Inorganic Chemicals Used in the Industries Will Prove a Convenience to the Experienced Chemist. The Writer Claims No Originality for the Synonyms, but Only the Bibliographical Research of the Material at Hand.

Part IV Will Appear in the Next Issue.

PART III

Cadmium. 112.4.

It has a specific gravity of 8.6, a fusing point of 228°C., melts at 321° C., boils at 778° C. and has a valency of two.

Cadmium was discovered at about the same time in 1817 by two independent workers under varied conditions. Strohmeyer, one of the two to whom the credit for its discovery was given, while engaged in some work on a sample of zinc carbonate, obtained from the zinc mines at Salzgitter, noticed that the oxide contained a yellow color, yet was free from iron. In 1818 he published a full account of his work and also named the element.

Hermann, at the same time, made an examination of a sample of zinc oxide which was used for pharmaceutical purposes and which had been rejected because, upon treatment with acid, it gave a yellow solution. He announced a new metal.

Shortly after Strohmeyer and Hermann made known their work on the new element, Meissner and Karster confirmed their report.

- Cadmium Chloride. 219.35
  - *Chloride of Cadmimum*
  - *Muriate of Cadmimum*
  - *Cadmic Chloride*
  - *Butter of Cadmimum*
- Cadmium Oxide. 128.4
  - *Cadmii Oxidum*
  - *Cadmic Oxide*
  - *Protoxide of Cadmimum*
- Cadmium Sulfate. 280.53
  - *Cadmii Sulfas*
  - *Sulfate of Cadmium*
  - *Vitriolate of Cadmium*
  - *Cadmic Sulfate*
- Cadmium Sulfide. 144.47
  - *Cadmii Sulfidum*
  - *Cadmic Sulfic*
  - *Cadmium Yellow*
  - *Jaune Brillant*
  - *Greenockite* (native)

Calcium. 40.07.

Although metallic calcium was not prepared until 1808 by Davy, its compounds were used by the ancients.

The use of lime in the preparation of mortar for building belongs to the pages of unknown history. Dioscorides and Pliny, in their writings, give a very complete description of the process for lime-burning and slaking.

This metal has a specific gravity of 1.545, a melting point of 800° C. and sublimes a little above this point. It has a valence of two.

- Calcium Acetate. 176.13
  - *Calcii Acetas*
  - *Diacetate of Lime*
  - *Pyrolignite of Lime*
  - *Vinegar Salts*
  - *Brown Acetate*
  - *Grey Acetate*
- Calcium Carbonate. 100.07
  - *Calcii Carbonas Precipitatus*
  - *Precipitated Chalk*
  - *Spanish White*
  - *Carbonate of Lime*
  - *Spanish Whiting*
  - *Whiting*
  - *Paris White*
  - *English White*
  - *Limestone (native)*
  - *Marble (native)*
  - *Calcite (native)*
  - *Aragonite (native)*
- Calcium Chloride. 110.99
  - *Calcii Chloridum*
  - *Chloride of Calcium*
  - *Muriate of Lime*
  - *Muriate of Calcium*
- Calcium Fluoride. 78.07
  - *Calcii Fluoridum*
  - *Fluor Spar*
- Calcium Hydroxide. 74.09
  - *Calx Extincta*
  - *Aqua Calcis*
  - *Calcium Hydrate*
  - *Slack Lime*
  - *Calcic Hydrate*
  - *Lime Water*
  - *Solution of Lime*
  - *Caustic Lime*

---

*All rights of publication in book form reserved by the author. Research Textile Chemist, 251 Clifton Place, Brooklyn, N. Y.

Calcium Hypochlorite. 215.05
Calx Chlorinata
Calx Chlorata
Chlorinated Lime
Bleaching Powder
Chloride of Lime (improperly called)

Calcium Oxide. 56.07
Calx
Calx Uiva
Caustic Lime
Quick Lime
Lime
Calcic Oxide
Burned Lime
Unslaked Lime

Calcium Sulfate. 172.17
Calcii Sulfas
Pearl Hardener
Gypsum (native)
Silenite (native)
Alabaster (native)

Dried Calcium Sulfate. 136.14
Calcii Sulfas Exsiccatus
Anhydrous Calcium Sulfate
Plaster of Paris
Dried Gypsum
Calcined Gypsum
Bihydrate of Lime
Calcined Plaster
Vitriolate of Lime
Vitriolate of Calcium

Calcium Phosfate. 310.29
Calcii Phosfas
Phosfate of Lime
Bone Ash (crude)
Bone Earth (crude)
Tricalcic Phosfate

Chromium. 52.

It has a specific gravity of 6.92, a melting point of 1505° C. and a boiling point of 2200° C.

A peculiar feature of chromium is its atomicity, which is diatomic, tetratomic, and hexatomic. It has also shown octatomicity.

Our first notice regarding chromium was contained in a private communication of Lehmann in 1762. For the benefit of a friend he described a new mineral which came from Siberia. Nothing definite was done regarding its composition until twenty-seven years later, when Vauquelin and Macquart investigated the mineral. Their results were not satisfactory, but they concluded that it contained a large quantity of lead and oxygen. In 1797 Macquart, not feeling satisfied with the results he had previously obtained, carried out a new investigation. He found that the lead was combined with the oxide of a new metal. To this was given the name Chromium. The mineral from which the study was made is now called Crocoisite.

Chromium Dichloride. 122.92.
Chromii Dichloridum
Chromous Chloride
Muriate of Chrome
Protochloride of Chrome
Butter of Chrome

Chromous Oxide. 84.
Protoxide of Chromium
Dioxide of Chromium
Green Oxide of Chrome
Chrome Green

Chromium Oxide. 100.
Chromii Oxidum
Chromic Oxide
Chromium Sesquioxide

Chromium Trioxide. 152.
Chromii Trioxidum
Acidum Chromicum
Chromic Acid
Chromic Anhydride
Anhydrous Chromic Acid

Chromium Sulfate. 482.29.
Chromii Sulfas
Vitrolate of Chromium
Wool Mordant.

Cobalt. 58.97.

Cobalt has a specific gravity of 8.72 and a melting point of 1490° C. The valency in the cobaltous compounds is two, and four in the cobaltic.

The name cobalt carries us back to the days of Paracelsus and "Basil Valentine." In those days it was not used to denote the element, but meant instead "false ore."

In 1733 Brandt came to the conclusion that the blue color of glass was caused by a peculiar metal in the mineral used in its manufacture. He gave it the name of "kobalt."

Cobalt Chloride. 129.89.
Cobaltum Chloridum
Muriate of Cobalt
Hydrochloride of Cobalt
Dichloride of Cobalt
Cobaltous Chloride
Butter of Cobalt

Cobalt Oxide. 74.97.
Cobaltum Oxidum
Cobalt Protoxide
Oxide of Cobalt
Cobalt Black
Gray Oxide of Cobalt
Black Oxide of Cobalt
Cobalt Monoxide
Cobaltous Oxide
Asbolite (Native)

Copper. 63.57.

It has a specific gravity of 8.9, melts at 1065° C. and boils at 2310° C. It is diatomic in valency.

Copper was probably the first metal to be used by mankind. The reason for this was that it occurred in the native condition, and did not require any further treatment.

Copper Chloride. 170.52.
 Cupri Chloridum
 Cupric Chloride
 Subchloride of Copper
 Muriate of Copper

Cupric Oxide. 79.57.
 Cupri Oxidum
 Black Oxide of Copper
 Copper Monoxide
 Protoxide of Copper
 Melaconite. (Native)

Copper Oxide. 143.14.
 Cuprous Oxide
 Red Oxide of Copper
 Dinoxide of Copper

Copper Sulfate. 249.72.
 Cupri Sulfas
 Sulfate of Copper
 Copper Deutosulfate
 Blue Coppras
 Blue Stone
 Blue Vitriol
 Roman Vitriol
 Salzburg Vitriol

Iron. 55.84.

It is also known as Ferrum.

Iron has a specific gravity of 7.8, melts at 1505° C., and boils at 2450° C.

It has a valency of two when the salts are ferrous, and four when ferric.

Iron is another of those few elements, the history of which began with the history of mankind.

Ferrous Carbonate 133.86.
 Ferri Carbonas
 Ferri Subcarbonas
 Carbonate of Iron
 Protocarbonate of Iron

Ferric Chloride. 270.32.
 Ferri Chloridum
 Ferri Perchloridum
 Ferri Sesquichloridum
 Iron Chloride
 Sesquichloride of Iron
 Perchloride of Iron
 Trichloride of Iron
 Muriate of Iron

Ferric Oxide. 159.68.
 Ferri Oxidum
 Ferri Sesquioxidum
 Ferri Rubigo
 Rubigo
 Ferri Peroxidum
 Ferri Oxidum Rubrum
 Peroxide of Iron
 Red Oxide of Iron
 Iron Rust
 Sesquioxyde of Iron
 Crocus Ferri
 Crocus Martis
 Ferrugo
 Polishing Crocus
 Jeweler's Rouge
 Venetian Red
 Stone Red
 Indian Red
 Purple Oxide
 Scarlet Red

Ferrous Oxide. 71.84.
 Ferri Oxidum
 Monoxide of Iron
 Iron Monoxide
 Suboxide of Iron
 Iron Suboxide

Ferrous Sulfate. 278.02.
 Ferri Sulfas
 Ferrum Vitriolatum
 Protosulfate of Iron
 Sulfate of Iron
 Coppras
 Green Vitrol
 Sal Chalybis
 Salts of Steel
 Vitriolate. of Iron
 Iron Vitrol

Ferric Sulfate. 562.03.
 Ferri Tersulfas
 Persulfate of Iron
 Sesquisulfate of Iron
 Tersulfate of Iron.

Analysis of the Chemist—Qualitative and Quantitative

By the Youth

Our neighbor, the *Canadian Chemical Journal*, is responsible for the publication of the following extremely amusing bit of satire, which we herewith reproduce in full:

Ottawa, the Ides of March.

A chemist is a thin film of matter, one atom deep, which clings to industry like a scum for support. He travels in more disguises than any Sherlock ever dreamed of and gathers infinitely less booty along the way. His temerity is such that he would think twice before holding up a fly—for more salary. Every chemist is the best chemist that ever carried rotten results to four places of decimals. His sense of co-operation with any other chemist is less than that of an exploding powder plant. A "professional chemist" is a misnomer. There is no such profession. Ask the first real professional man you meet and he will tell you.

The only things in a chemist's world are other things. If you introduced him to a man getting $200 a month he would probably blush, lift his hat, and how. He blows his own horn with the same sense of probable effect as a man learning to play a clarionet. He feels in his soul that it is just barely possible that the public needs education to appreciate him so he spends his spare time telling his closest friend—the stenographer—what a "basic industry" is. For him all the real salaries are in Peru.

Being a true descendant of one Dalton he still imagines himself to be a "perfectly elastic sphere," without pockets, or hooks of attachment of any kind visible or invisible. Having less general intelligence than the average potato he refuses to sprout. Some abnormal specimens have been known to sprout, but it never ran to two generations and is by no means contagious. He jumps from one "job" to any other with the alacrity of a cat and with the same "green field far away" look in his eye. The words, "position," "manager," "executive," were left out of his dictionary.

Having attended lectures and mopped up experience on all subjects at great price—except that variety given gratis by barbers and street car conductors' unions—he feels more than confident that he can pass the buck up to the whole world all alone. Should he by any chance fail to sustain the 20 per cent. dividend of his firm he has a most peculiar sense of dying game in the attempt. He has the same cause as the early Christians for desiring wealth in the future world.

His ancestors are the most notorious ancestors on record. He is in direct line with all the thugs of the Middle Ages. With such a handicap it is no wonder that the leading grocers refuse him the chance of leaving his card, even today, while the doctors, lawyers, and dentists, turn up their noses in utter scorn, crying "Unclean!"

Only such things as plagues and epoch making wars have a ghost of a chance of blowing the debris and junk on his head. Sometimes by reading carefully between the lines of his own trade journals he thinks he sees emancipation for him. Being thus encouraged by his cosmopolitan view he again approaches the stenographer, whom he finds has a date on with the lawyer—a future premier. So after all he guesses the war might not stop if he slept in the morning. They would probably go after each other with stones anyway. Cogitating thusly he deftly lowers the trap door over his head once again. Relatively speaking, "going down."

T. N. T. Plant to be Erected.

Announcement has been made that work will be started at once on the erection of one of the largest plants in the United States for the manufacture of T. N. T., to be located at Hercules, Cal. The plant will form an addition to the works of the Hercules Powder Co. Details as to the plant's capacity are not as yet forthcoming.

NEW PUBLICATIONS

"Finding and Stopping Waste in Modern Boiler Rooms."

By Engineers of the Harrison Safety Boiler Works, Philadelphia, Pa.; cloth; 9 inches by 7 inches; pages 276; 213 illustrations; $1.00.

The saving of coal is the purpose of this practical handbook, which is addressed to power plant owners, managers, engineers and fireman. The preface states that such statements, tables, charts, etc., have been selected as were supported by experiments and tests, references being given wherever possible to the original authorities. The latter include many well-known engineers and writers in technical periodicals, also authors of papers before engineering societies, while the excellent bulletins on the utilization of fuel issued during recent years by the United States Bureau of Mines have been freely drawn upon. Pains have been taken to compare statements and to check each source of information against others.

The work is divided into five sections, the first of which is about "Fuels," under which are considered the coals of the United States and their classifications, size of coal, coal sampling, proximate analysis, ultimate analysis, heating value of coal, ash and clinker, value of coal for steaming purposes, purchase of coal under specification, washing of coal, storage and weathering of coal, coal measurement, oil fuels and gaseous fuels.

The second section is on "Combustion," taking up the chemistry of combustion, air theoretically required, grates and grate surface, hand firing methods, thickness of fire, mechanical stokers and their operation, furnace temperature, furnace gases, clinker, draft, flue and stack proportions, draft required by stokers, mechanical stokers, draft gages, dampers, flue gas temperatures, flue gas analysis, Co_2 recorders, what CO_2 indicates, what CO indicates, air requirements and supply, preventing excess air, smoke and smoke prevention, burning oil fuel, burning gaseous fuels, and burning powdered coal.

The third section treats of "Heat Absorption," including heat transmission by conduction, convection and radiation, heat transfer from a fluid in a channel, heat transfer in economizers, air heaters and superheaters, improving heat absorption, relation between heating surface and boiler capacity, boiler setting, refractories and fire brick, soot, scale, softening feed water, and feed water heating.

The fourth section on "Boiler Efficiency and Boiler Testing" covers heat balance, heat absorbed by boiler, heat losses due to moisture in the coal, hydrogen, chimney gases, CO, combustible in the ash, mosture in the air, and unaccounted for loss, efficiencies, efficiencies with different coals, boiler capacity and efficiency, and boiler trials.

The fifth section on "Boiler Plant Proportioning and Management" discusses various arrangements of auxiliaries with regard to their effect upon feed heating, and also describes the Polakov functional system of boiler room management.

The book has been compiled by George H. Gibson, Member American Society Mechanical Engineers, assisted by Percy S. Lyon, now Captain of Coast Artillery. The proofs were read by Mr. Henry Kreisinger, who conducted for the U. S. Bureau of Mines many of the investigations quoted in the text.

New Publications of the U. S. Bureau of Standards.

Scientific Paper 313: Specific Heat of Liquid Ammonia.

The Bureau's investigations of refrigeration constants have included the careful study of the thermal properties of ammonia. Such calorimetric data are of primary importance in the computations of tables adapted to the needs of the refrigeration engineer. The determination of the specific heat of liquid ammonia has been attended with considerable difficulty, but the progress in artificial refrigeration has made it a matter of great importance. The research gives the specific heat through the range —45° to +45° C. within one part in a thousand. The results are tabulated for convenience in use.

Scientific Paper 314: Latent Heat of Pressure Variation of Liquid Ammonia.

This paper describes the research of the amount of heat needed to neutralize the temperature change of a substanc with a definite change of pressure. This change is sufficiently large to be taken into account in actual calorimetry. This constant was determined by three independent methods with satisfactory concordance of results.

Scientific Paper 315:Latent Heat of Vaporization of Ammonia.

This paper gives detailed description of the calorimeter designed to determine the latent heat of vaporization of ammonia. This important refrigeration constant was determined through the temperature interval —42° to +52° C. At 0° the latent heat is 301.8 calories per gram. The results of 34 separate determinations agree with the mean within one part in one thousand.

Recent Literature of Interest to Color Chemists.

"Colors for Hair Tonics," The Druggist's Circular, 1917, No. 12,637.

"Coal-Tar Color for Aromatic Castor Oil," The Druggist's Circular, 1917, No. 12,636.

"Invisible and Sympathetic Inks," The Druggist's Circular, 1917, No. 12,633.

"Removal of Stains from Clothing and Other Textiles," Farmer's Bulletin No. 861, U. S. Dept. Agr., by Harold L. Lang and Anna H. Whittelsey.

"A Book on Vegetable Dyes," by Ethel Mairet, published by Douglas Pepler, Hampshire House Workshops. 2d ed.

"Fuel Research Board, England," see Science for 1917, No. 1195, page 506. Six important lines of research are outlined and the experimental laboratory has been started.

"Electromerism—A Case of Chemical Isomerism Resulting from a Difference in Distribution of Valence Electrons," by L. W. Jones, University of Cinn., see Science, vol. 46, No. 1195, page 493.

"Annual Report of Tariff Commisison for 1917."

"Determination of Xylene in Solvent Naththa," P. E. Spielmann and F. B. Jones, J.S.C.I.

"Formation of Toluene by Action of Anhydrous Aluminum Chloride on Xylene and Benzene," F. Fischer and H. Niggermann, Berichte J. D. Chem. Gesell.

"Studies in Contact Catalysis; Decomposition of Ethyl Alcohol." C. J. Engelder. Jour. Phys. Chem., 1917, 21, 676.

"Contact Catalysis, II, Fractional Combustion." W. D. Bancroft, John. Phys. Chem., 1917, 21, 645.

Sulphate of Ammonia, Its Source, Production and Use, Circular No. 84, issued by the Barrett Co., N. Y. Attention should be called to this circular as it is much above the average.

Société de Chimie Industrielle.

Paris le 25 Février, 1918.

Monsieur le Directeur de Chemical Engineer.

Nous avons l'honneur et le plaisir de vous annoncer la constitution en France, d'une "Société de Chimie Industrielle."

Fondée pour établir une liasion permanente entre la Science et l'Industrie, cette association groupe déjà les notablitiés des diverses régions de notre Pays. Son Conseil d'administration comprend les personnalités les plus éminentes de l'Industrie. Le Comité de rédaction de ses publications est composé des noms les plus marquants de la Science. C'est en quelque sorte l'alliance de toutes les forces vives de France décidées à agir en commun, pour:

1°. Contribuer â l'expansion de l'Industrie chimique dans tous ses domaines;

2°. Grouper tous les chefs d'industrie: Professeurs, Ingénieurs, Chimistes, Constructeurs, etc., qui y sont intéressés;

3°. Contribuer aus progrès de la Chimie Industrielle tant au point de vue économique qu'au point de vue scientifique.

Une Revue technique constituera l'organe officiel de notre groupement et servia de trait d'union entre tous nos membres. Destinée à les entir au courant, non seulement des travaux re nos compatriotes, mais encore des nouvelles recherches scientifiques entreprises dans les différents Pays, elle s'attachera à élargir de plus en plus le domaine des inteventions pratiques de la Chimie.

Avant la guerre, nos deux nations ressentaient ensemble tout le poids des efforts de la Chimie allemande et de l'envahissement de ses porduits. Elles luttent en ce moment pour la même cause: la défense de l'humanité et l'émancipation du Monde. C'est un devoir pour elles, maintenant qu'elles se sont libérées de l'étrein te si lourde de pensar à l'avenir et de le préparer.

Depuis de longues années et en particular ces temps derniers, nos rapports nous ont apris à nous mieux connaitre et à nous apprécier davantage. Cet accord confiant et parfait qui préside aux relations cordiales que nos nations respectives entre tiennent doit être continué aprés la guerre, si nous voulons que la victoire porte ses fruits. Notre triomphe sur les champs de bataille doit s'accompagner d'une forte organization économique interalliée, afin de déjouer les nouveaux plans de domination commerciale et industrielle que viennent d'élaborer les empires centraux.

A l'heure ou dans tous les Pays de l'entente, les hommes soucieux d'un avenir heureux fécond, songent à ces lendemains d'efforts communs et d'inébrenlable amité, il est bon que les grandes associations multiplient entre les divers peuples aliés, les moyens de pénéeration réciproque, les échanges de pensées, de sympathie et de vues pour l'avenir.

La diffusion des publications scientifiques & techniques peut aider, dans une large mesure, à affermir et à accroitre les sentiments qui unisent nos deux patries. Nous la faciliterons, de notre côtée, avec toute l'ardeur de nos aspirations.

Nous nous permettons de faire appel à votre sympathie et venons vous demander dans quelles conditions vous seriez décidés à titre de propagande, à nous envoyer, pour la bibliothéque très importante que nous constituons, les diverses publications susceptibles de nous intéresser, notamment:

"The Chemical Engineer."

Nous pourrions, peut-être, faire un échange de nos publications. Mais, comme notre Revue ne paraitra qu'en Avril porchain nous vous serions très reconnaissants de nous faire "don," pour notre bibliothèque, des numéros de l'année 1917.

Le Sechétaire-Général,
JEAN GERARD.

Matheson Now Heads National Aniline.

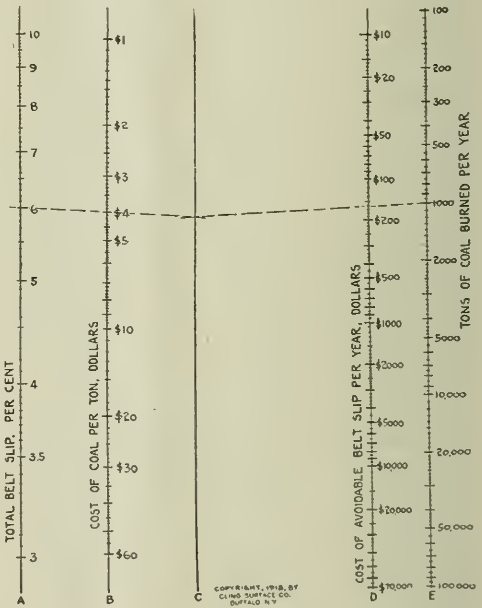
As a result of the reorganization of the National Aniline & Chemical Co., J. L. Schoellkopf and C. P. Hugo Schoellkopf, former president and third vice-president respectively, have withdrawn from its active management, but will continue as directors and stock-holders. The new president is William J. Matheson, a director of the General Chemical Co., while Dr. L. C. Jones of the Solvay Process Co. is vice-president.

The Cost in Coal of Avoidable Belt Slip.

Avoidable losses are the ones to stop, always, especially if they can be stopped at small expense.

Never before have we understood the stategic and money value of coal as thoroughly as we do now. Never before has it been so necessary for us to save, even though considerable money must be spent in order to effect the saving.

One of the very simplest losses to overcome, however, and at small expense, is belt slip, and since belts are used to so great an extent it will pay to look into the matter with more thoroughness than has been given it in the past. To show the extent of the loss of money through slipping of the main belt alone, a chart, supplied us through the courtesy of the Cling-Surface Company, Buffalo, N. Y., is shown herewith, upon which this is easily ascertained. By glancing up and down column "D" of this chart it is evident that the "Cost of Avoidable Belt Slip per Year in Dollars" may vary all the way from the smallest sums into the thousands of dollars.



Where the power in the first place is generated by a steam engine and is then transmitted to a generator or to the main shaft through a main belt, it is evident that the "entire coal pile" passes through that in the form of energy, literally speaking. If the belt slips, which it should not do, a certain portion of the coal pile does not "get through," but is lost into the atmosphere in the form of waste heat.

A main belt is merely a "link" connecting the engine with the generator or with the machines themselves. In fact every belt that transmits power is a connecting link and the efficiency of that link depends largely upon the freedom from slippage and the avoidance of strain on the shafts.

A Power Plant Is a Train of Links.

For the moment it might be well to dwell upon this thought, as it is seldom looked at in just this light.

We have for the first link the coal on the grates, which only perfect combustion can turn into maximum heat; next the boiler shell and tubes—they must be clean to bring the heat link to the steam link; next the steam line from boiler to engine or turbine—large enough and well insulated; then the engine or turbine link which joins heat energy and mechanical energy—only careful design, proper valve setting and much care minimize losses here.

Then, where power is distributed solely through belts and pulleys, the belts, pulleys and shafts or electrical cables to the final motors and belts are the connecting links up to the very machines themselves.

If the efficiency of every link is maintained at its highest point, the power end of the plant is beyond criticism. The overall efficiency will then be very high. But if the efficiency of every link is low or indifferent, the overall efficiency of the power end will be distressingly low.

Mere Matter of Detail?

Many of us talk glibly about efficiency as though it could be acquired over night. Thus, one man has stated that "Efficiency is a mere matter of detail." His definition is all right, but detail is not "mere matter!"

Belt Slip Not "Mere Matter," Either.

For these various reasons, therefore, it is plain that power transmission through belting is a "detail" on which we should "plug" until all avoidable slip is eliminated. It is especially important, as stated before, where all the power passes through a single main drive belt. Each per cent of slip in such a belt represents a loss of one per cent of the coal pile.

Roughly, two per cent of the potential power in the driving pulley of the engine is represented by "belt creep." Its loss is unavoidable because of the elasticity of the belt. This has been recognized and provided for in the chart, so the reader can go ahead and connect known values, while the intersection with column "D" gives the avoidable money loss.

How to Use Chart.

Simply zig-zag across the chart twice with a straight-edge, as shown by the dotted lines, and the money loss is immediately found. Thus, if the total belt slip is 6 per cent. (column A) and the cost of coal per ton is \$4.00 (column B), run a straight line through those two points and locate the intersection with column "C." Then from that point of intersection run over to the tons of coal burned per year (which in this instance has been stated as 1,000 tons) and the cost of avoidable belt slip per year is shown by column "D" as being \$160.00.

Yearly loss due to belt slip is often considerably greater than \$160.00, for it must be remembered that this chart applies only to ONE belt—the main belt. If all of the distributing or secondary belts slip equally as much the yearly loss is double, triple or even four times as much as \$160.00.

"Total Belt Slip Per Cent."

To give a clear idea as to the meaning of "Total Belt Slip Per Cent." let us take an example. You find by means of a revolution counter that a given driven pulley is rotating only 940 times per minute. You figure that without slip it should rotate 1,000 times per minute; 60 revolutions per minute, therefore, are absolutely lost. Dividing this 60 by the r. m. p. that pulley SHOULD make you get 0.060 or 6 per cent. which is the "Total Belt Slip." After having made this determination, now it is a simple matter to apply it to the chart, as has been done, and determine the money loss per year due to such slip.

Furthermore, belts which do not slip do not require tension and can be run easy or slack—every belt thus relieved of its tension reduces by that much the total plant friction load and this means also a longer-lived belt, cool bearings, less oil used, less time of men and machines lost during repairs and more power at the machines, for friction represents lost power.

To Increase H_2SO_4 Output.

Announcement has been made by the Tennessee Copper Co., New York that the output of its sulphuric acid plant at Ducktown, Tenn., will be increased to 3,000,000 tons annually.

Monsanto Works Acquires Acids Plant.

Following an increase in capitalization to \$5,000,000, the Monsanto Chemical Works, St. Louis, Mo., will carry on the manufacture of sulphuric, nitric and carbolic acids at its recently acquired plant at East St. Louis. The plant was purchased from the Commercial Acid Co.

Nitrates for Government Explosives.

The Atlas Power Co. has begun the construction of a \$6,000,000 plant for the manufacture of ammonium nitrate from sodium nitrate and ammonium sulphate. The plant will be located at Perry Point Farm, Md., and at the end of the war will be taken over by the U. S. government.

Enzymes

(Concluded from page 170)

Before baking the wheaten loaves (*Figs. 10 and 11*) the dough containing the mixed enzymes showed rapid raising power while at rest, with cracking of the outer pellicle. No sugar was added or required, due to the presence of saccharifying as well as fermenting and peptonizing enzymes.

The reason why enzymes withstand high temperatures in the dry state is due to lack of sufficient water to hydrolyze the "KEY," or anhydrid.

Acids, alkalies, H or OH ions and metallic salts, all destroy the protective colloid, hydrolyze the "KEY," or anhydrid, and kill the enzyme.

When enzymes are inactivated by elevated temperatures, the activity, or "KEY" is at times slowly regenerated on long standing. This is due to the re-combination, by the colloid, of the acid formed by the freed anhydrid.

Finally, it is the writer's belief that, having set forth the basic principles of those mysterious bodies known as enzymes and the method for their synthetic preparation, no longer is it necessary to say, with Prescott, that "only by their works shall they be known."

Cost of Creating a Merchant Marine.

(Concluded from page 178.)

ship construction—a total of 636, of 3,124,000 deadweight tonnage. Shipbuilding program contemplated under additional Congressional authorization—a total of 600, of 5,000,000 deadweight tonnage. "Some" program—"some" merchant marine for a starter!

So to the German U-boat havoc America torpedoes back appropriations almost to the $2,000,000,000 mark, warning the Hun that the new commercial supremacy of the seas shall not go to Germany and that 1,636 new ships with an aggregate tonage of 10,924,000 will meet and beat his futile U-boat menace. And America's confidence and reliance that this shall come to pass, is backed by the patriotism that has found a new and effective consecration in the pouring out of billions for Liberty Loan bonds.

Industry in War Times.

(Concluded from page 180.)

and hearings, to determine what are the less important industries, measured by the extent of their contribution, directly or indirectly, toward winning the war.

3rd. To promulgate such findings and to prepare, present and, if practicable, enforce such definite and concrete plan or plans as will result in—

- (a) Stimulating the operation of industries of exceptional importance.
- (b) Curtailing the operation of the less important industries or, **in the alternative, encouraging such industries so to change their operations as to produce war needs.**
- (c) Conserving the supply of essential raw materials as reserves to be drawn upon to meet the war requirements.

Artificial Dyestuffs in Italy.

(Concluded from page 177.)

growing dread in Germany of American competition. They are as follows:

"The manufacture of coloring matter has been gradually improved in all Allied and neutral countries, and there is no doubt that against the pre-war monopoly of Germany a powerful competition has arisen; that by breaking, at least in part, the monopoly will give to the commerce of these products a thoroughly different character. If the success of some of these competitors may be doubted, there is no question that Great Britain has already achieved a very noteworthy step forward towards independence. This may be said also of the United States of America, that has reached a very high stage of progress in the manufacture of these products, and promises not only to satisfy all home demands, but also to commence a large shipping trade.

"Those who have been able to read of late the German technical publications will have noted that, while they are hopeful of the possibility of meeting English competition, they regard with real anxiety the development of the American industry, so unexpected and so formidable.

"On the other hand, it is certain that the German industry is preparing itself for an enormous effort to reconquer the monopoly previously enjoyed; an effort that has only been made known abroad by the formation of a trust, having a capital of a milliard of marks, and comprising without distinction all the color works. The nature of the enormous technical efforts to be employed is, however, kept secret.

"A formidable battle will therefore take place between the German chemical industry and its competitors for the monopoly of the world's market: and this is foreseen to be so formidable that the Swiss firms preferred to retain their neutrality at present, desiring to see how matters shape, and continuing for the moment in their exceptionally favorable position from which they reap all possible advantage."

This feeling in Europe that our American color industry is firmly rooted and that it is bound to be a growing factor in world trade is practically an echo of the conviction in the hearts of those engaged in making it a success that the period of uncertainty is past. It requires only the continuance of the same unwearied pluck and versatile adaptation which have been displayed during the past two and a half years to ensure the final triumph.

FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Dyes.

26100—A firm in China desires to secure an agency for the sale of dyes. Cash will be paid, if necessary. The firm will also make outright purchases. Correspondence may be in English. References.

Pyrometers.

26218—An agency is desired by a man in France for the sale of agricultural motor pumps and dynamos for lighting. Also gas ovens and pyrometers. Correspondence should be in French. Reference.

Chemical Products and Oils.

20030—An agency on a commission basis is desired by a man in France for the sale of metals, industrial oils, chemical products, rubber, leather, and wood. Correspondence may be in English. References.

Industrial Chemicals.

26072—A man in France desires to represent American manufacturers and exporters of a general line of goods, such as food products, greases and oils, industrial chemicals, cereals, general light hardware, etc. All business is desired on a commission basis. Correspondence should be in French. References.

Calcium Carbide.

26061—A man in Alberia is in the market for 10 tons of calcium carbide. One-fourth cash will be paid with order and balance against presentation of documents at destination. The goods should be packed in casks weighing between 50 and 70 kilos. Correspondence should be in French. Reference. Prices should be quoted in francs, if possible.

Chemical Products.

26097—A man in Portugal is in the market for chemical products. Quotations should be made f. o. b. New York. Payment will be made against documents. Correspondence may be in English. References.

Dyestuffs and Chemicals.

26299—A firm in Argentina desires to receive agencies from American firms for the sale of dry goods, hosiery, tapestry, office supplies, chemicals, and dyestuffs. Correspondence may be in English. Reference.

Phosphoric Fertilizers.

25821.—A firm in the Azores wishes to buy phosphoric fertilizers, sulphuric copper, and sulphuric iron. Lowest cash quotations are desired f. o. b. New York. Correspondence may be in English.

Heavy Chemicals, Dyestuffs, Acids.

26343.—A business man in Australia wishes to purchase cocoa butter, cocoa beans, vegetable and carbon blacks, lithopone, essential oils, liquorice, bark extracts, heavy chemicals, dyestuffs, hematin, white and red lead, zinc oxides, formic acid, lactic acid, glues and gelatine, turpentine, peroxide soda, cornuba wax, vanilla crystals, and pigments. Payment will be made by letter of credit or in London. References.

Machine for Oil Extraction.

26367.—A merchant in Africa desires to purchase a small machine for the extraction of oil from sesamum seed. Payment will be made by cash against documents at destination. Correspondence should be in French or Italian. Reference.

Rubber and Leather Beltings.

26378.—A man in Canada who represents wholesale merchants and manufacturers in the Netherlands is in the market for rubber tires for bicycles, motorcycles, and automobiles; rubber, balata, cotton, and leather beltings; lubricating oils, greases, and graphite. Quotations should be made f. o. b. New York. Terms will be arranged through New York bankers against bill of lading.

Industrial Chemicals, Dyes, Paints.

26520.—A firm in the United States with branches all through the Far East desires to be placed in communication with American manufacturers and exporters of steel and iron products, hoop iron, box strapping, rails, wire and wire nails, industrial chemicals, disinfectants, dyes and drugs, paints, varnishes, building material, machinery, beer, wines and spirits, and canned goods. A representative of the firm is leaving for the Orient, and they desire to receive offers from American firms desiring to extend their trade to Java, Siam, French Indo-China, China, Japan, and the Celebes Islands. References.

DISTILLATES

News Notes of Chemical and Allied Industries

To Make Direct Cotton Colors.

The manufacture of direct cotton colors will be begun immediately at the new $50,000 plant of the American Color Co., at Scranton, Pa.

To Re-Build Plant.

Work will be begun at once by the Webster-Warnock Chemical Co. to reconstruct its chemical manufacturing plant at Memphis, Tenn., which was recently destroyed by fire with an estimated loss of $25,000.

Potash as Portland Cement By-Product.

Announcement has been made by the Ogden Portland Cement Co. that if experiments now being made prove satisfactory, the manufacture of potash will be undertaken at once at the company's plant at Baker, Utah.

Jefferson Graphite Co.

The Jefferson Graphite Co. has been incorporated with a capital of $20,000 at Birmingham, Ala., to engage in the production of graphite by George R. Sincix, L. B. Gunville and M. Hughes, Birmingham.

Norcross Co. to Make H_2SO_4 and HNO_3.

A sulphuric and nitric acid plant is being erected at Pueblo, Colo., by the Norcross Chemical Co., of Denver. The engineers in charge of the construction are from the Kalpberry Corp., New York.

Du Ponts to Load More Shells.

Plans are going forward for the construction of a new shell-loading plant by the E. I. du Pont de Nemours Co., Wilmington, Del. The plant will be located at Dundalk, Md.

Grasseli to Make Nitric Acid.

Construction work has already begun on a nitric acid plant costing $1,000,000 to be erected at New Castle, Pa., by the Grasseli Chemical Co. The plant will form an addition to the company's Covert's Station Powder Plant.

Fries & Fries to Operate Yonkers Plant.

Fries & Fries will manufacture water-proof coatings, syrups, etc., at Yonkers, N. Y., according to recently completed plans.

Richfield Oil Co. Increases Holdings.

The Richfield Oil Co. has recently acquired the plant of the Phoenix Refinery Co., Bakersfield, Cal., and has under consideration the construction of a local compressor plant for the extraction of gasoline from high gravity oil.

Maas & Waldstein to Enlarge Plant.

At Newark, N. J., the Maas & Waldstein Co., manufacturers of chemicals, are planning for the erection of a new addition to their plant in Avenue R to cost $12,000.

Independent Chemical Co.

With a capital of $4,500,000, the Independent Chemical Co. has been incorporated at Dover, Del., to manufacture chemicals and allied products. The incorporators are W. B. Walsh, Brooklyn, N. Y., J. A. Lyon, New York City and V. Harris, Pelham Manor, N. Y.

Krayer Chemical Co.

The Krayer Chemical Co. has been incorporated with a capital of $50,000 at Elizabeth, N. J., to manufacture chemicals, by Dr. Stephen S. Krayer, A. Krayer, H. Jacobs and Clarence S. Myer, Elizabeth.

Alphano Humus Co.

With a capital of $4,000,000, the Alphano Humus Co. has been incorporated at Boonton, N. J., to engage in the manufacture of fertilizers. The incorporators are John N. Hoff, Boonton, Richard Sellers, Bellevue, Del., and James E. Mantee, Portland. Me.

Johnson Chemical Co.

With a capital of $200,000, the Johnson Chemical Co. has been incorporated at Raleigh, N. C., to manufacture chemicals and kindred specialties. The incorporators are James I. Johnson, James I. Johnson, Jr., and J. W. Cross, Raleigh.

Liberty Leather Co.

The Liberty Leather Co. has been incorporated at Dover, Del., with a capital of $100,000 to manufacture leather and leather products by M. L. Horty, F. D. Buck and K. E. Longfield, Wilmington.

Day Chemical Co.

The Day Chemical Co., with a nominal capital of $5,000, has been incorporated at Chicago, Ill., to manufacture chemicals and allied products. The incorporators are Jas. D. Day, Robert A. Levener, R. H. Clinton and Hilgard B. Young.

McCarthy-Fox Chemical Co.

The McCarthy-Fox Chemical Co., Manhattan, has been incorporated under the laws of New York with a capital of $1,000, to deal in chemicals, drugs, etc. Incorporators are William V. McCarthy, M. C. McCarthy and Alfred J. Fox.

THE *SIXTH* OF MAY THRIFT STAMP DAY IN THE U. S. A.

Important Change of Date

Thrift Stamp Day Advanced to Monday, May 6th

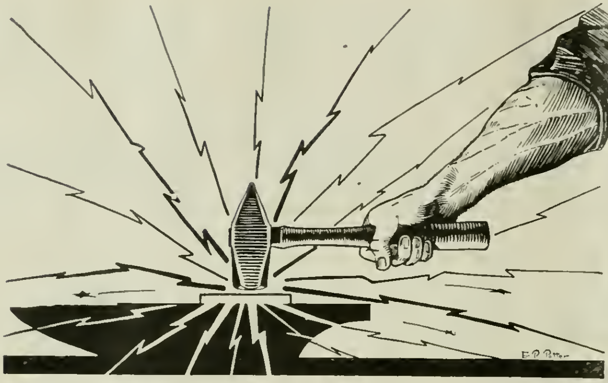
It has been decided to advance Thrift Stamp Day in the U. S. A. from the First of May to the *Sixth* of May, in order to avoid conflicting with the wind-up of the Liberty Loan Drive which ends May 4th.

This Change of Date Will Help the Success of Thrift Stamp Day

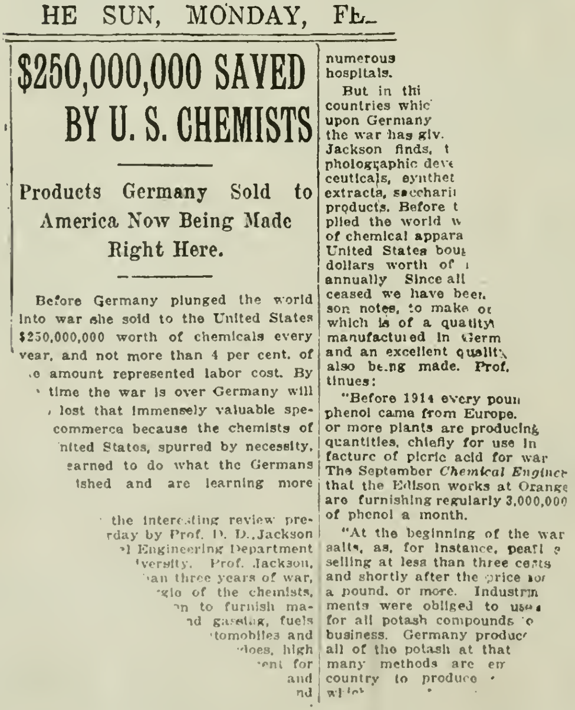
It gives American business five days more to prepare for "The Biggest Business Day in History."

It means that the American people will have nothing else to distract their attention from Thrift Stamp Day.

May 6th is a Monday, which means that Thrift Stamp Day will fall on the day when people will have more money to invest in Thrift Stamps and to buy things at the Special Thrift Sales.



STRIKE While the Iron's Hot!



HE SUN, MONDAY, FE

$250,000,000 SAVED BY U. S. CHEMISTS

Products Germany Sold to America Now Being Made Right Here.

Before Germany plunged the world
into war she sold to the United States
$250,000,000 worth of chemicals every
year, and not more than 4 per cent. of
.e amount represented labor cost. By
time the war is over Germany will
lost that immensely valuable spe-
commerce because the chemists of
nited States, spurred by necessity,
earned to do what the Germans
ished and are learning more

the interesting review pre-
rday by Prof. D. D. Jackson
l Engineering Department
versity. Prof. Jackson,
an three years of war,
glo of the chemists,
n to furnish ma-
nd gaseing, fuels
tomobiles and
does, high
ent for
and
nd

numerous
hospitals.

But in thi
countries whic
upon Germany
the war has giv.
Jackson finds, t
photographic deve
ceuticals, synthet
extracts, sacchari
products. Before t
plied the world w
of chemical appara
United States bou
dollars worth of
annually Since all
ceased we have been
son notes, to make or
which is of a quality
manufactured in Germ
and an excellent quality
also being made. Prof.
tinues:

"Before 1914 every poun
phenol came from Europe.
or more plants are producing
quantities, chiefly for use in
facture of picric acid for war
The September *Chemical Engineer*
that the Edison works at Orange
are furnishing regularly 3,000,000
of phenol a month.

"At the beginning of the war
salts, as, for instance, pearl
selling at less than three cents
and shortly after the price
a pound, or more. Industrm
ments were obliged to use
for all potash compounds
business. Germany produc
all of the potash at that
many methods are em
country to produce

Capitalize on the situation which now prevails in the industrial chemical field.

Never before has the opportunity for business in chemical manufacturing and allied fields been as great as it is to-day.

The present demand for equipment, apparatus and chemical products runs into big figures.

The CHEMICAL ENGINEER is the connecting link between producer and consumer in this great field. Your advertisement in its pages would prove a *profitable investment*—not an expense.

THE CHEMICAL ENGINEER
118 East 28th Street New York, N. Y.

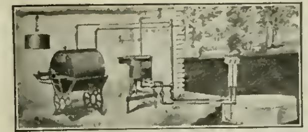
U.S. Acid Proof Paint

SEND FOR SAMPLE ON TIN—READY TO TEST

This paint is proof against the most destructive acids and alkalis, or fumes of the same, in any strength, even to chlorine. It is also proof against steam conditions and dampness.

U. S. ACID PROOF PAINT contains no oil, asphalt, coal tar or pigment. It air dries in about 30 minutes and is permanently flexible. It will adhere to any surface, will not dry out, crumble or peel, and is non-deteriorating even when subjected to the most severe conditions. It is a deep black, will stand dry heat to 350 degrees Fahr. and is highly electrolysis proof.

United States Varnish Company
41 Park Row NEW YORK CITY



GAS
for
Laboratory and Industrial Uses
Automatically and Cheaply Made by the
Detroit Combination Gas Machine
Over 30,000 in Daily Use
The Ideal Plant for Cooking, Lighting, etc., in Homes
Descriptive catalog and names of users in your locality sent on request.
DETROIT HEATING & LIGHTING CO.
616 Wight Street, Detroit, Mich.
Established 1868

WANTED

One complete set, bound volumes, of the CHEMICAL ENGINEER, Vols. 1 to 25, inclusive. Also send for list of back numbers wanted. Address Editor, 118 E. 28th St., New York City

YOU ARE NOT ASKED TO GIVE—

INVEST!

The United States Government is anxious to pay you a good rate of interest on your spare change. Think of *that* the next time you spend a quarter on some unnecessary trifle. The belief that one quarter is too small to make any difference is highly gratifying to a certain Emperor. You must *keep on investing*—try buying just one Thrift Stamp *every day*—and watch your money grow.

HELP YOURSELF *HELP YOUR COUNTRY*

BUY WAR SAVINGS STAMPS

Bring Us Your Dyestuff Problems

The application of dyestuffs to textiles is as important as their production. The technique of this branch of the color industry has for years commanded the best talent among those dyestuff distributors who have catered to the highest class of trade.

An intimate knowledge of the possibilities of every dyestuff is often necessary to meet the particular requirements of the consumer. Dyeing is a chemical, not a mechanical, process, and the variation of local conditions, due to differences in quality of water, steam and chemicals, makes the dyehouse problem an individual one.

Such problems are welcomed by the technical department of this company, which is manned by chemists who have been picked because of their knowledge, practical experience and demonstrated ability. We have long maintained well-equipped laboratories at our different offices for this purpose, and invite inquiries and extend, without any obligation on the part of our customers, our services to all who stand in need of them.

National Aniline and Chemical Company

INCORPORATED

21 Burling Slip, New York

THE CHEMICAL ENGINEER

VOL. XXVI. APRIL, 1918 No. 6

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00. Single Copies, 25c.

Statement of the Ownership, Management, etc., Required by the Act of Congress of August 24, 1912,

Of the Chemical Engineer, published monthly at New York, N. Y., for April 1st, 1918.

County of New York, State of New York, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Robert H. McCready, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Chemical Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 413, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, McCready Publishing Co., 118 East 28th St., N. Y.; editors, Thos. H. Norton, 118 East 28th St., N. Y.; L. T. Clark, 118 East 28th St., N. Y.; managing editor, none; business manager, R. H. McCready, 118 East 28th St., N. Y.

2. That the owners are: C. J. O'Brien, 22 North William St., N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him. ROBERT H. McCREADY.

Sworn to and subscribed before me this 1st day of April, 1918.
FREDERICK PFISTER.
(My commission expires March 30, 1919.)

CONTENTS, APRIL, 1918

The Amylo Saccharification Process.................. 204
J. S. Horn
Comparative Tests of Porcelain Laboratory Ware... 208
C. E. Waters
Decrease in Sicilian Sulphur Exportations............ 210
Coal-Tar Chemistry Section.............................. 211
Edited by Thomas H. Norton
—German Dye Recipes for British Textiles........... 211
—Manufacture of Explosives from Aromatic Hydrocarbons 213
—Manufacture of b-Naphthol Benzoate............ 213
—A New Method of Producing the Leuco Derivatives of Vat Dyestuffs.............................. 213
—A Bee-Hive Coke Oven with By-Product Recovery 214
—A New Vat Dye.. 214
—New Phenolic Bodies for Use in Tanning........ 215
—Formulas for German Dyes........................ 215
—German Patents.. 216
—Electrochemical Synthesis of Aromatic Hydrocarbons 217
—German Dyestuff Companies....................... 218
—The Physical Basis of Color....................... 218
Ultra Violet Light: Its Application in Chemical Arts. Part XIII 219
Carleton Ellis and A. A. Wells
Improvements in the Manufacture of Synthetic Phenol 232
Exports of Indigo from Madras....................... 232
Inorganic Chemical Synonyms. Part IV.............. 233
Elton R. Darling
Civilian Workers Wanted for Ordnance Department 235
New Publications 235
—"Polarimetry"
—New Publications of the U. S. Bureau of Mines.
Chemical Investigation, Efficiency and Control........ 237
Conducted by Charles B. Davis
How Much Money Goes Up Your Chimney in a Year? 238
Foreign Trade Opportunities............................ 239
Distillates 240

The Logwood Supply of Haiti

Haiti has been for many years among the sources of supply for logwood. The United States has imported annually from 50,000 to 100,000 short tins for over twenty years.

The logwood has, thus far, been derived chiefly from the forests adjacent to the coast. The interior contains large tracts of logwood growth practically untouched and awaiting modern methods of transportation. At present, the annual cut is far from representing the equivalent of the annual growth of logwood. During the unprecedented high prices for logwood prevailing during 1915-16 considerable amounts were cut in the interior and brought to coast ports, but were not shipped until the sudden break in quotations made it impossible to sell without loss. Vast stocks of these accumulations, at various coastal points, still await purchasers. The world's demand for logwood will be permanently much in advance of the consumption of 1913-14. There would seem to be an admirable opportunity to lay the foundations for a permanent exploitation of the Haitian inland forests, by constructing a few short lines of railway and establishing the facilities for easy and expeditious shipment. Conditions are favorable for American capital to secure an economic position on the island, which may be of the greatest value ultimately.

THE AMYLO SACCHARIFICATION PROCESS

By

J. S. HORN

As a result of a paper read before the Society of American Bacteriologists at its 19th annual meeting, December 27, 1917, in Washington, D. C., on "The Importance of Pure Culture Work in Industrial Processes," several interesting communications have been received which indicate that the "Amylo Process" is very little understood indeed.

The information has been received from one source that, some years ago, a Peoria concern had a mold process installed which apparently proved a failure. Not knowing the details of this process, it is quite difficult to point out the reason for this. It may be said, however, that the director must combine the following qualifications in order to successfully work out a process of this type on an industrial scale, i.e.: (1) He must be an excellent manipulator in pure culture work; (2) he must be a good chemist and able to put theories into practice; (3) he should have a fair idea of constructive engineering; for unless the plant is well laid out, the consumption of steam and the chances of infection, etc., are materially increased.

A second argument advanced is that the amylo process cannot compete with the malt saccharification process. This has been disproved repeatedly. One concern was persuaded to employ the malt process after running the amylo for two years. A one month's run convinced them thoroughly as to which was the cheaper. The writer has built one plant and operated it for two years, and operated another for four and a half years. The following is the economic side as outlined for a southern concern:

A company in the South operated an 1800 bu. house during 1917. The yield per bu. never exceeded 4.80 proof gallons. A check on a one day's run revealed that 160 bu. of corn in excess of the amount allowed were used to obtain a fair yield. The manager, well versed with Middle West distilleries and reputed to have obtained yields as high as 5.13 P. G. per bu. of corn, left after a one week's run. The reason was obvious. The plant is poorly installed and the climatic conditions are such that the malt process and the highly treasured jug yeast (which grandma brought from Ireland three generations ago!) were a total failure. However, these same conditions are all in favor of the amylo process.

Mr. J. C. Mims, Industrial Chemist of New Orleans, was commissioned to investigate the practicability of the amylo process of saccharification. His recommendation favored proceeding with the installation. The preliminary work revealed the following facts:

Total mashing capacity of the small unit	1800 bu.
Small grain (rye and malt) 56 lb. per bu.	11% $2.75 per bu.
Corn per bushel	89% $1.61 per bu.
Cost price of 1800 bu	$3,123.72
Value of residue (dried distiller's grain) at $40.00	270.00
Total	$2,853.72
Total production of alcohol (4.80 P. G per bu.)	8640.00 P. G.
Cost price of grain only, per proof gall	$0.31

Saving due to superiority of amylo process:

Corn at $1.61 per bu. 1800 bu	$2,898.00
Total alcohol produced (5.20 P. G. per bu.)	9,360.00
Difference in cost price of grain	$ 225.70
Increased value of production	259.90
Increased value of distiller's grain	180.00
	$665.60
Total in favor of amylo process per year of 312 days	$207,667

The cost of installing the additional equipment was about $35,000, or, let us say, $45,000, to meet any unforeseen war prices in material. Thus it may be seen that an investment of $45,000 would not only conserve 43,200 bu. of corn per year—which is of vital importance to Mr. Hoover's work just now—but in addition would bring $207,667.20 at the most conservative estimate at prevailing prices, or approximately 461.5% on the capital invested. In normal times the margin of profit would be smaller of course, but still worth while.

This does not take into consideration the economies due to saving in steam, water, labor, etc. The concentration of the amylo mash is 28 gals. per bu. of corn, instead of 45 gals. by the old process and $\frac{1800}{28} \times 45$ or about 2,900 bu. can be mashed in the 1,800 bu. equipment. Under these conditions 2,900 bu. of corn are worked much more economically than the 1,800 under the malt process. There was a $12,000 refrigerating machine, which was not needed because the mash was cooled to 40° C. only. The waste of cooling water and steam in the vacuum pump is something enormous in the warmer latitudes. The mash pump, running practically 12 hrs. to cool the mash of 1,800 bu., is also done away with. The mash is blown from the cooker into the amylo tank directly by its own steam pressure. After the tank is filled the mash may be cooled at leisure. Any one who has fought with poor water conditions in warm countries know what that means. A 3,000 bu. house of the amylo type can get along with a 5-inch water pipe line, while on the other hand this 1,800 bu. house had two 6-in. lines and most of the time either had to suspend cooling or shut down the vacuum pump.

The main operation—mashing—is carried on according to the following schedule: Obeying governmental restrictions in regard to operating a distillery, the amylo process must be carried out in two different operations, (1) mashing, saccharification, (2) fermentation. That is to say, the mash must be cooked into one tank, where saccharification is accomplished, and when the appropriate hour arrives, whether ready or not, this mash must be passed to another tank known as the fermenter. For this cooking the Government storekeeper weighs out 200 bu. of corn meal into each cooker, or 11,200 lbs., 3 cookers in a series, preferably of the Henze type—but any other will do.

The meal is slowly added to about twice its weight of water. The water is heated to about 60° C. to prevent caking of the meal and either steam or air is passed through the cooker to prevent the formation of lumps at the bottom of the cooker which would clog up to the mash outlet. At the same time the steam or air will assist in thoroughly mixing the corn meal and water. Enough acid is added to the water in the cookers to bring the final acidity of the mash to .3 g. HCl per liter. The purpose of the acid is threefold: (1) The alkalinity must be neutralized, for the mold requires a slightly acid medium; (2) the acidity in the cooker assits the disintegration of the cellulose, making the mash more susceptible to the action of the mold; (3) the basic phosphate salts of the grain must be transferred into acid salts.

The steam is turned on and the mash brought to a boil for 10 minutes. As soon as the air is expelled the steam outlet pipe on top of the cooker is closed and partly opened again to allow a slight continuous flow of steam. The exhaust from the cookers passes through a sterilizer to preheat the water for completely filling the amylo tank.

The steaming of the mash is done rather gradually. During the first half hour the pressure is brought to 10 lbs. The next half hour a pressure of 25 lbs. is reached and held for 10 minutes. This is raised to 40 lbs. in another half hour, and again held for 10 minutes. The pressure is allowed to go to 50-55 during the next 20 minutes. Hold 10 minutes and blow mash into the amylo tank by its own pressure, flush the cooker, if of the horizontal type, and allow excess pressure to escape through the sterilizer or the tank, as the case may be. It takes about 25 minutes to empty the cooker.

After all mash (600 bu.) has been transferred to the amylo tank the sterilized water is run in to fill the tank. The filling line is then disconnected and the pipe blind-flanged to do away with a possible source of infection. Air is now passed through a cotton filter and enters the bottom of the tank, which is provided with a stirrer. The filtered air bubbles through the mash, which is at 104° C., and escapes through a 4-in. pipe at the top of the tank. This outlet pipe passes through a barboteur where a 4-ft. water seal prevents any access of bacteria from that direction. The air removes all steam in the mash. In about 30 minutes turn on the cooling water very gradually at first to avoid vacuum within the mash tank. This may also be avoided by allowing more air to enter.

The cooling is accomplished by running a thin sheet of water over the outside of the tank from a pipe encircling the tank on top. The spray holes are about 3 inches apart and slant toward the sides. This method of cooling is slow, however, and very wasteful with regard to water consumption. About 10 to 12 hours are required to cool the tank from 104° C. to 40° C. It is advisable to install cooling coils, especially in the larger tanks (20,000 to 40,000 gals. capacity) in order to save time and cooling water. One hundred feet of a 2-in. copper pipe has proven very satisfactory—the cooling being accomplished in less than 6 hours, and the consumption of water less than in the first instance.

As soon as the temperature drops to 43° C. the mold is introduced. For this purpose there is a cock riveted to the top of the tank, which is provided with a rubber extension closed by a copper plug. An assistant with an alcohol torch carefully heats the plug, and also the neck of the 1 liter spore flask. The plug is now withdrawn and at the same time the neck of flask inserted and the mold spores poured into the tank. The stirring device, together with the air, thoroughly distributes the spores. When the spores are introduced germinating, in order to gain time, the wort is added to the flask about 6 hours previously. The time gained in saccharification is about 4 hours, but, on the other hand, there are some disadvantages. The mash may be too warm yet, or not very favorable in other respects, and the growth of the filaments greatly stunted when transferred from a favorable medium to a less favorable one.

Twenty-four hours after the addition of the spores a sample is taken from the tank in order to determine the purity (microscopically) and the amount of gemmae and filaments, which latter is seen best when suspending some of the mash in a glass of water. The growing mold is in appearance like so much cotton wool, and if any infection is present the mold shows a peculiar growth, not easily described, but immediately apparent to the practiced eye. The reducing sugars and the acidity are very important. The acidity is best determined by a standardized calcium hydroxid solution.

The specific gravity is not of importance except as an incidental check. While the gravity of the hot mash is between 14° and 15° Brix, as soon as the temperature drops some of the starch separates out and the gravity is about 11° Brix. This precipitated starch is easily attacked when saccharification is at its maximum. If the yeast culture is an old stock it may be added as soon as an increase of sugar is noted. However, if the yeast culture is fermenting it is not added until about 45 grams of sugar are present. In 24 hours the yeast is very numerous and fermentation proceeds rapidly. At this time the total sugar present should be between 95 gr. and 105 gr. per liter. If below, the yeast may gain too rapidly and the mold suffer, or, if above 105-110 gr., the mold may become sluggish so far as the diastatic action is concerned and settle down to feast on its products. In either case incomplete saccharification results.

Within the next 24 hours fermentation is at its height, and the gravity drops to about 1.0° Brix. In another 24 hours the gravity registered is about minus 0.3° to 0.5° Brix and the mash is ready for the still. The acidity may rise to 0.8 g. of H_2SO_4 per liter at the finish.

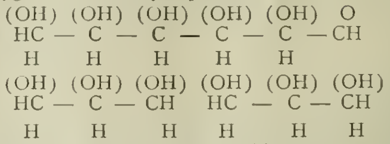
The residue may then be dried and the oil extracted, if the corn oil has not been removed before cooking. The filtering of the residue proceeds smoothly. The mold acts somewhat as a filter pulp or diluent of the extractive matter. The cake contains about 60 per cent. of water. An average analysis of the dried residue when the corn oil is not removed is as follows:

Moisture	6.0— 7.5%
Fat	19.0—23.0%
Protein	37.5—39.0%
Carbohydrates	38.0—40.0%
Ash	1.9— 2.5%

Synthetic Glycerine.

One of the most promising fields of the mucor application, however, may be the production of synthetic glycerine. While experimenting with bacteria of the *granulo bacter* variety, the writer found that whenever a hydrogen producing bacteria was working in an amylo mash, in the presence of calcium carbonate, the proportion of glycerine increased some 5 times over the normal The conclusion drawn was that nascent hydrogen is in some way connected with the phenomenon. A repetition of this, eliminating all other possible factors, proved the assumption to be correct, although it was noted that an alkaline condition existed at the same time. Previous to this it was observed in molasses fermentation, as well as amylo work, that alkalinity is essential to obtain a higher glycerine yield. The general conclusion is that the glycerine content is inversely proportional to the acidity of the mash and that the higher types of yeast produce less than the wild yeasts. The natural yeasts, like grape yeasts, in presence of cream of tartar, produce more than any pure culture yeast, but as soon as the acidity rises, due to fermentation, the glycerine content remains stationary. Whether this results from the increase in acidity alone, or perhaps from the decomposition of a certain amount of the glycerine formed, is difficult to determine without thorough research.*

Viewing the subject from a strictly theoretical point of view, we see that sugar has 5 hydroxyl groups and 1 oxygen in the aldehyde position:



$$\underset{H}{\overset{(OH)}{HC}} - \underset{H}{\overset{(OH)}{C}} - \underset{H}{\overset{(OH)}{C}} - \underset{H}{\overset{(OH)}{C}} - \underset{H}{\overset{(OH)}{C}} - \overset{O}{CH}$$

$$\underset{H}{\overset{(OH)}{HC}} - \underset{H}{\overset{(OH)}{C}} - \underset{H}{\overset{(OH)}{CH}} \quad \underset{H}{\overset{(OH)}{HC}} - \underset{H}{\overset{(OH)}{C}} - \underset{H}{\overset{(OH)}{CH}}$$

Fructose did not respond to this treatment and no glycerine was formed.

Thus in the presence of nascent hydrogen the position of the aldehyde oxygen becomes unstable and as soon as it assumes the hydroxyl state the molecule ceases to exist as sugar. The only possible substance it can be transformed into under the existing conditions is glycerine.[1] There is no difficulty in explaining the action. Oxidizing any aldehyde to the corresponding acid involves the introduction of an oxygen atom to form a hydroxyl in a hydrogen position. In this case the hydrogen acting on the oxygen liberates an additional valence which will be immediately satisfied by an atom of nascent hydrogen. This being accomplished, the substance becoming unstable will very naturally split symmetrically. The resulting two carbon valences will be satisfied by additional nascent hydrogen. The glycerine thus formed is saturated and consequently is *hors de combat.*

From this the deduction was made that if the sugar was hydrogenated to supply the 4 hydrogen atoms essential to the reaction, glycerine should result. Such was indeed the case. A glucose solution suspended in an oil, with finely divided nickel as a catalyst, (no palladium being available), was put under a steam pressure of over 100 lbs. and nascent hydrogen introduced. The yield of glycerine varied between 5 per cent. and 10 per cent. The factors were not worked out in detail but we may feel assured that glycerine can be manufactured from glucose.

The above experiments were conducted with the material resulting from the amylo process. It is probable that the reaction is far more complete when cane sugar is inverted, thus dealing with practically chemically pure substances.

Summarizing, we may say that the attempt to bring about the formation of glycerine by fermentation, on a profitable scale, has not yet succeeded. Whether alkaline fermentation will solve it remains to be seen.

Mucor and the Fermentation of Acetone and Higher Alcohols.

The application of the amylo process to bacterial fermentation is in its infancy. It is not known to the writer whether the mold saccharification has been applied to the manufacture of acetone, butyl alcohol, fusel oil, butyric acid, etc. While experimenting with so-called heat-proof bacteria in order to obtain fusel oil, it was noted that whenever the culture tubes were sealed off, a rather pleasant odor was observed upon opening the tubes. Subsequent tests in a rarified carbon dioxid atmosphere revealed that no butyric acid or fusel oil were present, but instead a large amount of an organic substance having a boiling point of between 60° C. and 110° C. Fractionation gave two distillates—one boiling close to 65° C. and the other close to 115° C. Repeated distillation brought the boiling point of the latter fraction to between 115° and 117° C. The first fraction was discarded at the time as impurities of the butyl alcohol. Further tests made at the Bacteriological Laboratory of the Louisiana Sugar Experiment Station with the generous permission of Prof. Taggart and Dr. Kopeloff, director and bacteriologist respectively, showed that the first fraction was the more valuable, namely acetone.

---

*Tests made with yeast obtained from Calif. Wine Assn., San Martin, Calif.; type unknown, season 1915.

[1] Sorbitol probably differs in constitution from hydrogenated glucose.

The bacteria servicable in this work belongs to family VIII, Bacillaceae, group 2, Clostridium Prazmowski 1880, according to the classification in the Journal of Bacteriology, Vol. 2, No. 5, page 562. These bacteria are very well described by Bredemann in *Zentralblatt fur Bakteriologie,* 2te Abt. Band 23, No. 1420, pages 386 to 568. While Bredemann made an attempt to prove that all different varieties are alike, it is well understood that some differ radically from the rest, especially in respect to the end-products of fermentation. The granulobacter pectinovorum, apparently the bacteria employed by Effront (U. S. patent 953,025; 3, 29, 10), and Bac. amylobacter are best adapted to this fermentation. The adaptation will take at least 6 months of careful cultivation. The butylic bacillus of Fitz, (Fernbach U. S. patent 1,044,368; 11, 12, 12) was not satisfactory at all and it is supposed that the diclosure is a camouflage. This patent refers to "a ferment of the character of the butylic bacillus of Fitz." The patent is so worded that any one filing a subsequent application cannot obtain a patent.

The method worked out takes advantage of the saccharifying power of the amylomyces alpha, beta or gamma, but the beta strain is perhaps better because it does not ferment any sugar. The bacterial culture may be introduced with the mold, but it is advisable to at least partially saccharify the mash. This will allow the mold to act on the nitrogenous bodies, making them available for bacterial metabolism. In a mash for this fermentation, which is preferably set around 10 degrees Brix, the mucor grows rapidly and in 10 hours the saccharification is well under way. As soon as the rise in sugar is noted the pure culture of the granulobacter is added.

These spore-forming bacteria are anaerobic. The air, which is essential for the development of the mucor, must be cut off as soon as the iodine test becomes negative and all air displaced by carbon dioxid. A partial vacuum will assist this process, but is not at all essential for the fermentation. In presence of air the same bacteria will form butyric acid to a large extent.

Normally, the bacterial fermentation is complete in from 48 to 55 hrs. The total time consumed is about as follows:

Cooking and filling of the amylo tank	5 hrs.
Cooling of mash to 40 C.	6 "
Development of the mucor	10 "
Saccharification	24 "
Fermentation (not over)	55 "
Emptying of tank	2 "
	102 "

It will be seen that about 4½ days are required for a complete cycle. The vinasse from this fermentation is, of course, utilized for butyric acid fermentation, in view of the fact that a complete change cannot be brought about. This is very important, for the reason that the process might prove a commercial failure, but for the saving of the by-products. A judicious addition of albuminoid matter may raise the yield about 5 per cent. A production of 20 per cent. of the weight of the grain may be counted on. Some precautions must be followed rigorously, as the bacteria changes very much until the habits are well established. Even then steady sporulation and sterilization must be practiced in order to keep the strain from degenerating.

The Production of Table Syrup.

Some experiments have been made to see whether it would be feasible to treat corn for the production of glucose by means of molds. The procedure is somewhat different. The cooking period must be shortened and the acidity kept as low as possible in order to avoid the formation of caramel. The production may be too low, though, when the corn is not sufficiently cooked, for the growth of the mold is very fast in this case. The diastatic power is not in proportion to the development of the mycelia.[2] If cooked too much, the caramel formed has an inhibiting effect on the growth of the mold and while the inversion is very complete the period is considerably lengthened. As before noted, the sugar content should at no time be more than 110 grams per liter for the reason that the mold would act on its own products. Therefore, the mash must be of such a concentration that when the total starch is inverted it does not contain more than 11 per cent. of sugar. About 45 gallons of mash to the bushel of corn mashed will give a solution of between 9.7° and 10.2° Brix, which when saccharified will give just the right amount of glucose. This saccharification is completed in about 36 hours. The glucose solution is now heated to 65° C. to complete the saccharification, which while killing the mucor seems to make the enzyme of the mucor readily available for additional inversion. Mashes up to 14° Brix have been satisfactorily inverted in that manner, when 11° Brix would have been about the maximum.

The liquid is then filtered, the residue containing the mold is pressed and the solution added to the filtrate from the filter press. The protein matter may now be precipitated as well as the dextrine, and the filtered solution concentrated, passed over vegetable bleaching char, (that made from southern yellow pine has been

(*Concluded on page 236.*)

---

[2] Has also been observed by Currie, J. of Biol. Chem., Vol. 31, No. 1.

COMPARATIVE TESTS OF PORCELAIN LABORATORY WARE

By

C. E. WATERS*

Porcelain is of but slightly less importance than glass in the chemical laboratory. In ordinary use it soon becomes evident whether or not the ware is mechanically strong and whether it is able to withstand sudden changes in temperature. In exact analytical work it is equally important that the glaze should offer the maximum resistance to attack by reagents. For many years chemists had at their disposal certain makes of ware which were of excellent quality, so that the resistance of porcelain to reagents was almost a laboratory byword. The placing on the market of ware from other sources and the inability to obtain the familiar brands made it desirable to subject both the new and old kinds to a series of comparative tests.

At the outset it was recognized that the results would probably not be as clear cut and definite as those with glass. The weight of the porcelain prevented the testing of crucibles and dishes above a certain limited size. This meant that only a small surface of presumably highly resistant material would be exposed to attack. In addition, the shapes of the crucibles, and still more of the dishes, varied for the different makes, so that with a given volume of reagent not necessarily the same area of glaze would be attacked. During the progress of the work it was found that this factor was of slight importance, because the losses due to the action of the reagent were usually so small as to be negligible for most analytical work. After all it is desirable to know to what extent a given volume of solution may become contaminated, rather than how many square centimeters of porcelain it will wet.

Brands Tested

At the time the tests were made only five makes of glazed porcelain ware could be obtained. In the laboratory stock the necessary number of Royal Berlin dishes, but no crucibles, was found. Meissen ware could not be obtained, but dishes and crucibles of "Bavarian" ware were purchased. In addition to these, a supply of Japanese brand, marked "S. C. P.," and of two American makes, Herold (Coors) and Guernsey, were bought. All of the purchases were made in the open market.

The dishes were the largest that could be placed upon the balance pans. Nominally 80 mm in diameter, they varied from 78 to 95 mm for the different makes. The crucibles ranged in height from 35 to 50 mm, and in diameter from 57 to 65 mm. The different pieces of any one kind of ware were quite uniform in diameter and in general shape, but the variations in thickness were rather large. This was shown by the weights, which varied as follows: Herold (Coors), 34.5 to 43.1 g; Guernsey, 36.2 to 44.5 g; Bavarian, 34.1 to 43.0 g; Berlin, 29.4 to 37.3 g; Japanese, 32.3 to 43.0 g. The last-named ware showed the maximum variation, which amounted to 33 per cent. These figures are for 33 to 36 dishes of each kind of porcelain.

Preparation of Pieces

Each piece was roughly weighed and, after having been arranged in the order of its weight, was lightly marked near the rim by means of a writing diamond. During the tests no breaks started at these diamond scratches. The lightest piece of each kind was used as a tare against which all weighings of that ware were made.

The pieces for the heating tests were not cleaned further than by wiping with a damp towel before the first rough weighing. The pieces used to test the action of reagents were rinsed with water, hydochloric acid (1:1), and again with water, after which they were wiped dry on the outside. They were then kept filled with distilled water for 20 hours, rinsed, wiped dry, heated to 110° for two hours, cooled in the air, and weighed not sooner than three-fourths hours and usually much longer after their removal from the air bath. The tares were heated with the test pieces before each set of weighings.

Selection of Test Methods

Suggestions as to the methods of testing and the reagents to use were received from various sources. No particular search of the literature was made, but it is believed that the fusions with sodium nitrate and the ignition with ferric oxide are new. The reasons for most of the tests are obvous, and for the others are given further on.

Experimental

All tests were made in duplicate, and the results are given in tabular form.

Sudden Cooling

Each piece was three-fifths filled with paraffin at 100° C, then brought to the desired temperature on a hot plate. It was then floated on water at room temperature. There were no failures on cooling from 200° C, but a number of dishes and crucibles cracked or broke when they were cooled from 225° C.

---

*Chemist, U. S. Bureau of Standards. From a recent Technologic Paper issued by the Bureau.

Sudden Heating

The pieces were placed on a wire triangle and heated in the full flame of a Fletcher burner of the Méker type. After 3 minutes the flame was removed and 10 seconds later the piece was removed with platinum-tipped tongs. By this time the porcelain had cooled to a pale straw-yellow, at which temperature it would ordinarily be placed in a desiccator or otherwise handled with tongs. Quite unexpectedly this proved to be an important test, for in many cases the glaze cracked where touched by the tongs. When this happened after the first heating, new cracks were formed after one or more of the three succeeding heatings of 2 minutes each. In no case did the cracks first appear after one of these later heats.

The Royal Berlin and Japanese wares withstood this test satisfactorily.[†]

Treatment with Sodium Hydroxide.

After the usual preliminary cleansing, drying, and weighing, each piece was placed on the steam bath and then 50 cc of 10 per cent. sodium-hydroxide solution was carefully poured in. The dishes did not rest in the openings of the bath but on thin plates of aluminum, in order to avoid the solvent action of directly impinging steam. After five hours' heating, 30 cc of water was added to each dish to make up for that lost by evaporation. An hour later the pieces were rinsed out under the tap, dipped into hydrochloric acid (1:1), again washed, wiped dry, heated in the air bath, and finally weighed after cooling in the air. A second treatment exactly like the first was given.

The losses in weight were greater than those caused by any other reagent, but the crucibles gave so much lower figures than the dishes that only the latter were used in the remaining solubility tests.

Treatment with Sodium Carbonate

The solution used contained 100 g of the anhydrous salt in 1,000 cc. The dishes were cleansed as for the preceding tests. There were two treatments of seven hours each. The losses by evaporation were made up by adding 10-cc portions of distilled water at intervals of about two hours.

Treatment with Sulphuric Acid

The cleansed and weighed dishes, each containing 25 cc of concentrated sulphuric acid, were heated on a hot plate for three hours at a temperature high enough to cause strong fuming. After washing out the acid and drying and weighing the dishes, it was noticed that one of them had a small crevice in the edge. Since this still contained acid, all the dishes were soaked in distilled water for three hours, rinsed, dried, and again weighed.

Treatment with Fused Sodium Nitrate

Since no oven suitable for use at temperatures above the melting point of sodium nitrate was available, the dishes were heated over burners. Thirty grams of the salt were placed in each dish and kept for two hours at such temperature that there was a slight crust around the edges, while most of the nitrate was in the fused state. The melted salt was poured out and the cooled dishes were soaked for one and one-half hours in running water, then rinsed with dilute hydrochloric acid followed by distilled water. They were wiped dry, heated to 110° C, cooled, and weighed.

The losses in weight under this treatment were so unexpectedly small that a new series of tests were made with the same dishes at a higher temperature. The same weight of nitrate as before was slowly heated up to the point at which a piece of charcoal floating on it caught fire. This required about 10 minutes. Under this treatment there were further losses, but the figures in the table, which show the combined losses during the two fusions, were still small.

Treatment with Fused Sodium-Nitrate-Carbonate Mixture

A mixture of 10 parts of sodium nitrate and 1 part of carbonate readily fuses to a clear melt at a temperature higher than the melting point of the nitrate alone, yet still below a red heat. The action of even this strongly alkaline reagent was slight when 33 g of it was kept just at the melting point for two hours. After the usual cleansing and weighing the dishes were soaked in distilled water overnight. The very small changes in weight thus resulting are evidence against any considerable porosity of the porcelain. The figures in the table give the total losses during the three fusions.

The glaze at the bottom of some of the dishes was dulled, but did not appear to have been badly attacked.

Ignition with Ferric Oxide

Ferric oxide so readily stains porcelain and is often so hard to remove as to suggest that it forms a silicate with the glaze. In this case the removal of the stain by prolonged digestion with hydrochloric acid might be expected to remove silica in soluble form, and possibly also other constituents of the altered glaze.

In order to coat the dishes as uniformly as possible with ferric oxide before ignition, the following procedure was adopted: To 20 cc of a solution of ferric nitrate (equivalent to 57 mg of Fe_2O_3) was added 5 cc of ammonia of half strength. The whole was evaporated to dryness, first on the steam bath and then in a radiator[‡]. This was followed by gentle ignition over a small flame and finally five minutes' heating in the full flame of a Fletcher burner. After cooling, the dishes were wiped as clean as possible and weighed. Although all were badly stained, their increase in weight due to adhering ferric oxide was in no case as much as 1 mg. To each dish there was added 40 cc of hydrochloric acid (1:1) which removed the stains by digesting on the steam bath for three-fourths hour. The dishes were soaked in running water for one hour, then cleaned, dried, and weighed. The losses in weight were all very small and gave no evidence of the formation of any considerable amount of soluble silicates.

[†] Samples of Coors ware of recent manufacture have been found to withstand this test.

[‡] Hillebrand, Bull. 422, U. S. Geol. Survey, p. 31, 1916.

Porosity

The dishes that had been used in the nitrate fusions were soaked overnight in an aqueous solution of methyl violet, then rinsed quickly and wiped dry. All were strongly colored around the unglazed rim, and the numbers scratched on by the writing diamond stood out plainly. The spots where the glaze was dulled were faintly dyed. Nearly all of the color was removed by soaking for 20 hours in distilled water. In no case was there any evidences of pores or channels in the body of the material. The purple band around the edge was sharply limited by the glaze and showed no sign of creeping in under it. The dyeing effect seems to be due to adsorption by the rougher parts of the surface.

Results of Tests on Crucibles

Nature of test	Herold (Coors)		Guernsey		Bavarian		Japanese	
Heated to 200° C with paraffin and cooled suddenly in water	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Heated to 225° with paraffin and cooled as above	(b)	(c)	(c)	(b)	(c)	(c)	(b)	(b)
Suddenly heated in flame of Fletcher burner	(d)	(d)	(e)	(e)	(d)	(d)	(f)	(f)
Changes in weight in milligrams when—								
Heated with 10 per cent NaOH for 6 hours:								
First treatment	−1.6	−1.9	−1.1	−1.6	−1.1	−1.6	−0.9	−0.7
Second treatment	−3.0	−1.0	−1.7	−1.4	−1.2	−1.4	−0.7	+0.2

[a] The ware withstood this test satisfactorily

[b] Did not crack.

[c] Cracked badly.

[d] Glaze cracked under tongs. Recent samples of Coors ware withstood this test.

[e] At third heat cracked badly at top and near bottom; glaze also cracked under tongs.

[f] No cracks in glaze.

Results of Tesis on Dishes

Nature of test	Herold (Coors)		Guernsey		Bavarian		Royal Berlin		Japanese	
Heated to 200° C with paraffin and cooled suddenly in water	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Heated to 125° C with paraffin and cooled as above	(b)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Suddenly heated in flame of Fletcher burner	(d)	(e)	(f)	(f)	(g)	(g)	(g)	(g)	(g)	(g)
Changes in weight in milligrams when—										
Heated with 10 per cent NaOH for 6 hours:										
First treatment	−2.3	−2.3	−2.8	−3.0	−2.5	−2.0	−1.4	−3.2	−1.0	−1.0
Second treatment	−2.6	−2.0	−2.5	−2.3	−2.4	−2.1	−0.6	−2.3	−1.2	−0.9
Heated with 10 per cent Na_2CO_3 for 7 hours:										
First treatment	−0.1	−0.1	+0.2	+0.1	−0.3	−0.3	−0.1	0.0	+0.3	+0.2
Second treatment	−0.3	−0.1	−0.8	−0.1	−0.3	−0.2	−0.1	−0.2	−0.3	−0.4
Heated with concentrated H_2SO_4:										
After washing	−0.1	0.0	−0.3	+0.1	0.0	−0.1	0.0	+0.1	0.0	0.0
After soaking (total)	−0.4	−0.4	−0.4	−0.3	−0.4	−0.3	+0.2	−0.3	−0.3	−0.4
Heated with fused $NaNO_3$ for 3 hours	0.0	+0.3	+0.1	0.0	+0.3	+0.2	+0.2	+0.2	+0.1	+0.1
Heated with $NaNO_3$ to ignition point of charcoal [h]	−0.5	−0.3	−0.5	−0.3	−0.3	−0.3	−0.5	−0.8	−0.6	−0.4
Heated with $NaNO_3$—Na_2CO_3 mixture for 2 hours [h]										
After washing	−0.4	−0.3	−0.5	−0.7	−0.7	−0.6	−0.2	−0.5	−0.8	−1.3
After soaking	−0.3	−0.3	−0.5	−0.3	−0.4	−0.4	−0.3	−0.6	−0.3	−1.2
Ignited with Fe_2O_3:										
Before HCl digestion	+0.5	+0.3	+0.5	+0.2	+0.6	+0.5	+0.4	+0.3	+0.3	+0.4
After HCl digestion	−0.1	−0.2	−0.1	−0.2	−0.1	0.0	0.0	0.0	−0.2	−0.1

[a] The ware withstood this test satisfactorily

[b] Broke.

[c] Withstood this test without breakage.

[d] Cracked all around on first heat. Recent samples withstood this test.

[e] Fell into two pieces on first heat. Recent samples withstood this test

[f] Glaze cracked under tongs on first heat

[g] No cracks developed

[h] These figures represent the total changes in weight after two or three fusions, respectively, with sodium nitrate

Decrease in Sicilian Sulphur Exportations

Consul Robertson Honey, Catania, Italy, writes that during the first ten months of the calendar year 1917, Catania exported 40,496 metric tons of refined sulphur as against 80,672 tons for the corresponding period of 1916. Continental Italy, France and England were the heaviest buyers (in the order named) and together took over 72 per cent. of the output of the entire island of Sicily. Of crude and refined sulphur combined Catania exported 51,120 tons in the 1917 period, as against 89,810 tons in 1916. The entire island during the two periods exported 143,002 tons in 1917 as against 383,329 tons in 1916.—Commerce Reports.

Nevada Cyanide Plant Running.

Production has been begun at the new 150 ton electrically operated cyanide plant of the Elkoro Mines Co. at Jarbridge, Nevada.

Represented A. C. S. at Chicago.

Dr. Julius Steiglitz, A. V., Mory and William Hoskins represented the American Chemical Society as delegates to the recent Congress of National Service held in Chicago.

Commercial Cylinder Co.

To manufacture gas, oils, etc., The Commercial Cylinder Company, Hackensack, N. J., has been incorporated under the laws of that State with a capital of $800,000. The incorporators are A. R. Oakley, Pearl River, N. Y., and Paul E. Britsch, Brooklyn.

Lambert Chemical Co.

The Lambert Chemical Company, St. Louis, Mo., has been incorporated with a capital of $30,000 to manufacture chemicals and allied products. W. and A. W. Lambert and A. R. Deacon, St. Louis, are the incorporators.

Will Make Fertilizer and Phosphate.

The Merchants Fertilizer and Phosphate Company, Charleston, S. C., has been incorporated with a capital of $25,000 to manufacture fertilizer and phosphate. The incorporators are E. H. Pringle, Jr., B. G. Pringle, F. E. Barron and A. F. Pringle, Charleston.

Germans View Dye Future "With Confidence."

According to the *Journal of the Society of Dyers and Colorists*, the annual report of the German color combine contains the following statement:

"Owing to the length of the war numerous competitive works have been established in neutral and enemy countries. A hard struggle with them is bound to come after the war. Sacrifices will undoubtedly have to be made; nevertheless, the future position may be regarded with confidence."

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors. Synthetic Medicinals, Flavors and Perfumes. Explosives, Photographic Developers.

Edited by

THOMAS H. NORTON, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

George H. Bruce, LL.B., Keystone Fibre Products Co., Inc., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hehden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles

H. Gardner McKerrow, of E. F. Drew & Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

German Dye Recipes for British Textiles

Consul Augustus E. Ingram, Bradford, England, writes in Commerce Reports that since the publication in a newspaper in this country on January 10 of the account of the success of a group of men in the British textile trade in bringing to England from Switzerland 257 secret recipes for the manufacture of aniline dyes, which have been in use in the Bidische chemical factories in Germany, the Yorkshire newspapers have had many articles on the subject, the majority of which state that considerable skepticism is felt on the subject by dyeing experts. The following views have been gathered from published statements and discussions:

Do Not Represent Whole Industry.

The British Board of Trade is reported to have said that as yet it had had no opportunity to test the merits of the claim. It was pointed out that the Badische Co. is only one of several German companies engaged in the manufacture of dyes. One of the latest catalogues gives exactly 1,001 dyes, each representing a distinct color, while the modifications—the finer shades of similar colors—run at least to 2,000 or 3,000. Different firms offer similar things under varying names, so that 257 recipes—a term which is not in accordance with the technology of the trade—must not be taken to represent the whole of the German dye industry.

One paper says that while recipes are of value, much more is necessary to put the domestic dyeware industry in a position after the war to meet the keen competition that is bound to be experienced from the formidable combinations that exist in Germany. There is need of large expenditure of capital, coordination, and efficiency of working.

Present Limitations in Production.

The absence of German aniline dyewares has compelled dyeing firms in England to turn to the natural dyewares, which, as is well known, involve more labor than artificial colors, while, of course, natural dyes can not be standardized or guaranteed as in the case of aniline dyes. The result has been that dyers for some time have had to limit the number of their shades and to withdraw their guaranties as to fastness. In other words, dyers have been content, more or less, to accept what they were able to get, thus creating an easy market for makers of dyewares.

The complaint of those who take a long view of this problem is that instead of utilizing the opportunity afforded by having the market to themselves to make such progress as will enable them to compete successfully with the Germans after the war, dyeware manufacturers in England have devoted far too much attention to the making of immediate profits. Mention is also made of petty rivalry between dyeware makers in the country.

On the other hand, practical men in the trade say that several firms are now producing important dyes that were not made in England before the war. Not long ago British Dyes (Ltd.) announced the production of the first three of a series of vat colors, the latest dyes put on the market by the Germans before the war, and other firms have been similarly energetic and enterprising in research work.

Too Much Emphasis on Secret Processes.

Prof. Arthur G. Perkin, head of the dyeing department in the University of Leeds, is reported in the Yorkshire Post to have said that he reserved judgment until a statement on the subject was forthcoming from an English expert of standing. He said there was much misapprehension in the public mind as regards color manufacture, and very general idea that the whole thing depended upon secret processes. There was, however, a very large range of dyes in the actual formation of which no essential difficulty occurred, and the recipes for the manufacture of these would not be of very special value.

The reason why these had not been made previously in this country was not a lack of knowledge as to the formation of the dye itself, but a lack of experience in the economical preparation of the more or less intermediate materials from which the dyes were prepared, and unless, therefore, the recipes in question included a knowledge of these facts, they would not be of much benefit to Great Britain.

Importance of Experience and Plant.

On the other hand, without doubt there were many important coloring matters, the details of the preparation of which, possessed only by the Germans, are essential to their economic large-scale manufacture. A knowledge of these facts would materially benefit English factories. A recipe, however, might mean little without the experience, which often had to be hard-earned, of the working of such processes on the large scale, and again, a very important factor with the manufacture of some special dyes was the plant that had to be employed—not only as to its form, but the special materials from which it had to be constructed. Prof. Perkin continued:

"It is unwise to jump to any conclusion as to the importance of recipes obtained in this peculiar manner, and in any case it would be quire ridiculous to infer that their possession will bring our color industries to the level of those in Germany. Should the matter really be of the importance it is assumed to be, it can do little more than act as a temporary help to our industries in case the knowledge is, as is suggested, to be shared out by our Government to them. It is not by the purchase of recipes abstracted from German factories that we are likely to recover our share in this important industry. The matter goes much deeper than this, and we can not hope to attain in as many months to that perfection which the Germans by patient study have taken nearly 40 years to accomplish.

"While there has been much criticism as to the efforts now being made to recover our lost position in the dye industry, in my opinion the larger manufacturers at least are doing almost all that is possible to effect this object. The main drawback they have to face is the lack not only of chemists in general, but more especially of those who have had any experience in color chemistry, and this is not to be wondered at, because until very recently, among all the educational establishments in the country, the Leeds University was the only one that offered any systematic instruction in this subject."

The burnt-green or apple-green color that was mentioned in the newspaper's original article is reported to be known as guiznets, or "guigennots," a brilliant green pigment, very difficult to produce in the proper shade. Indeed, it is said that that dye has never been produced economically in commercial quantities—not even in Germany.

In regard to the post-war demand for dyes it is of particular interest to note certain statements in the recent annual report for 1917 of Levinstein (Ltd.). This firm, in addition to a factory at Blackley, Manchester, where considerably more than 100 organic products which were never before manufactured in England are now being made on a large scale, is operating the indigo factory at Ellesmere Port, near Liverpool, formerly owned by a German firm. It states:

"The peace-time requirements of the textiles of this country are very different from the war-time requirements. At present the greater part of the textile industries is engaged on the production of military fabrics requiring large quantities of a comparatively small number of dyestuffs. In peace time the requirements are much more varied and consequently more difficult to meet, as a greater range of dyestuffs is then required. To manufacture the same weight of a greater range of dyestuffs needs much more plant than when as at present production is concentrated on fewer types. * * * For our Nation to be left at the mercy of Germany for its dyes at the conclusion of hostilities means that our textile trades will be placed in serious jeopardy.

Present Needs of Industry.

"No policy of free trade or tariff reform will provide our manufacturers and users with dyes if the plant does not exist and the materials can not be produced in this country in sufficient quantity to meet demands when they arise. To-day Germany alone possesses the amount of plant necessary to produce the bulk of these all-essential commodities."

They therefore urge the Government to give the necessary financial assistance and special priority for the erection of plant. Speaking of the steps already taken by the British Government, they say the amalgamation and pooling of resources, research, and knowledge, originally proposed, has so far not been achieved. The investment of £2,000,000 in British Dyes (Ltd.) has not solved the problem of obtaining adequate supplies of British-made dyes.

Some 15 months ago a joint committee of the dye makers and dye users drew up a list of the essential dyes—said to be 400 in number—that are required for the maintenance of the British textile trades, but no organized effort of a national character in the way of facilities for obtaining steel and other structural material for plant, raw material for the dyes, labor, and capital, has yet been made in the United Kingdom up to the present time.

Manufacture of Explosives from Aromatic Compounds

The ordinary practice of manufacturing explosives from aromatic compounds, notably from phenol and from toluene, is based upon treatment with nitric acid and sulfuric acid.

R. H. Twining and R. W. G. Wyckoff, of Geneva, N. Y. (Amer. Pat. 1,242,900, of Oct. 9, 1917), claim that they produce compounds of powerful explosive properties by simply fusing various aromatic substances with sodium nitrate or nitrite. Such substances are of necessity stable and non-volatile at the fusing temperatures of the alkaline salts ($NaNO_2$, 271°C.; $NaNO_3$, 315°C.).

The reaction has been carried out with sulfonates, benzoic acid and phthalic acids. Typical mixtures for fusion are 25 parts of $C_6H_5SO_3Na$ and 75 parts of $NaNO_3$; 18 parts of C_6H_5COOH and 82 parts of $NaNO_2$.

The formation of polynitroso and polynitro compounds is assumed, in harmony with the following equations:

$$C_6H_5SO_3Na + 5NaNO_2 = C_6(NO)_5.SO_3Na + 5NaOH$$
$$C_6H_5SO_3Na + 5NaNO_3 = C_6(NO_2)_5.SO_3Na + 5NaOH$$

The resultant products are described as explosive compounds of great power, incapable of being exploded by shock, even by hammering on an anvil or by pressure, but capable of being detonated by mercury fulminate or other detonators.

It would appear, however, as if these products would be far from rivaling the existing high explosives, such as picric acid and TNT. In the instances shown above by the equations, the final products contain inert matter to the extent of 58% in the case of the nitrite, and 50% in the case of the nitrate.

Manufacture of b-Naphthol Benzoate

Recent improvements in the manufacture of b-naphthol benzoate have been perfected by G. Blieberger, of New York, and the rights are assigned to the Anthony-Hammond Chemical Works, also of New York (Am. Pat. 1,254,970, of Jan. 29, 1918).

The benzoyl chloride used for the purpose is prepared by heating together in a steam-jacketed, enameled kettle, 100 parts of benzoic acid and 70 parts of phosphorus trichloride or pentachloride. The temperature is maintained at a point slightly below the boiling point of the chloride. After completion of the reaction, the benzoyl chloride produced is purified by distillation from a vacuum still.

In reacting upon b-naphthol, 155 parts of benzoyl chloride are required for 100 parts of the naphthol. The latter is introduced into a kettle provided with a reflux condenser, and heated nearly to 198°, the boiling point of the chloride. Under constant stirring the benzoyl chloride is allowed to drop gradually upon the naphthol and combination takes place rapidly. Fumes of hydrochloride acid are conducted from the condenser to a flue.

The product is allowed to cool. It is then taken out of the kettle, placed in water and washed. After washing it is allowed to settle and the water is decanted or drawn off.

The b-naphthol benzoate is next dissolved in warm alcohol, filtered through pure animal charcoal, and allowed to cool, this cooling step causing crystallization. It is then separated by filtering through cloth and is finally dried, and thus becomes a commercial product.

The method is claimed to give nearly a theoretical yield and is unaccompanied by any loss of benzoyl chloride.

A New Method of Producing the Leuco Derivatives of Vat Dyestuffs

The customary method of reducing indigo, the indigoids and the anthracene vat dyestuffs to the soluble, leuco form for the purpose of dyeing is to use sodium hydrosulfite, or, in some cases, zinc or ferrous salts with lime. André Brochet, of Paris, France, has devised a process (Amer. Pat. 1,247,927, of Nov. 27, 1917) based upon the use of hydrogen in the presence of catalyzer, such as platinum, nickel, copper and other metals, or various oxides. The dyestuff to be reduced is suspended with the catalyzer in an alkaline solution which is kept in violent agitation while hydrogen bubbles through the liquid. Pressure favors the reaction.

The following is a description by way of example of the manner in which the reduction of indigo can be effected:

Twenty grams of synthetic indigo and 10 grams of reduced nickel are mixed with 1 liter of water containing 10 to 20 grams of caustic soda, at a temperature of about 60 to 80° C.

The agitating apparatus containing the mixture is connected to an apparatus capable of supplying hydrogen and after displacement of the air, it will be found that the hydrogen is rapidly absorbed under the influence of the agitation.

The indigo white which is formed, enters into solution. When the reduction is completed, the nickel is allowed to settle, and the brownish yellow liquid is drawn off and is ready for use by the dyer.

The improved process is applicable in the same way as indigo, to thio-indigo and to derivatives of indigo and the thio-indigo, to vat dyestuffs such as the indanthrenes, &c., and generally to dyestuffs yielding leuco-derivatives under the action of reducing agents.

Instead of nickel other catalytic metals act with different degrees of effectiveness. The speed of the reaction depends on the proportion of catalyzer used.

Several pieces of apparatus may be connected in series, and the gas and the liquid containing the catalyzer may be caused to travel in opposite directions through them.

The improved process has the advantage of being easily applicable with gaseous mixtures containing hydrogen, for instance, water-gas.

It has over the processes at present in use, the advantage of allowing the economical production of concentrated solutions of leuco-derivatives free from impurities and mineral salts.

A Beehive Coke-Oven with By-Product Recovery

There have been various attempts to modify the construction of the beehive coke oven so as to render it less wasteful, none of which have proved to be of distinct value.

M. Marshall, of Port Coquitlam, British Columbia (Amer. Pat. 1,248,883, of Dec. 4, 1917), has recently devised an oven which aims to recover the major part of the solid and liquid by-products.

It retains the customary dome shape of the ordinary beehive oven. The floor slopes conically to a large grated aperture in the center, connecting with the condensing and scrubbing systems. The conical space above is filled with gravel or broken stone. Above this is a layer of fire brick with frequent openings. It forms the floor proper upon which the charge of coal rests. This is introduced through an opening in the top of the oven.

Drafts are so arranged that the charge is kindled and the upper surface is brought to a bright glow by means of air admitted from below. An uptake flue in the upper part of the oven serving as an exit for the products of combustion and distillation at the beginning, is then closed, and by means of a rotary pump air and steam are forced through the charge from above. As a result the volatile matter released passes downward, through the firebrick floor, and through the gravel beneath to the pipe leading to the condensers.

There is apparently no effort made to recover gas, and the gas would have a very limited thermal value. It is claimed, however, that the ammonia and the tar are both recovered in satisfactory amounts, and that the coke obtained is of a quality superior to that furnished by the ordinary beehive type of oven.

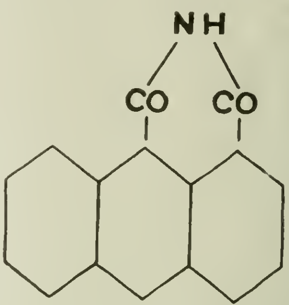
New Dye Manufacturers.

With a capital of $150,000 the Croton Color and Chemical Co. has been incorporated at Croton, Westchester County, N. Y., to manufacture aniline dyes. The incorporators are Paul P. Ihrig, Edward R. Vollmer and Frank C. Schmitz.

A New Vat Dye

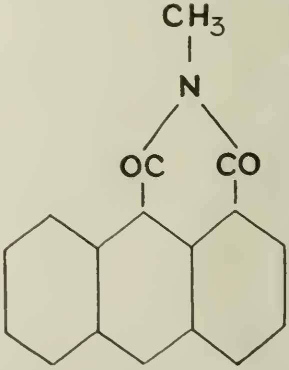
M. Kardos, of Charlottenburg, and Paul Nawiasky, of Ludwigshaven-on-the-Rhine, Germany, assignors to the Badische Anilin & Soda-Fabrik, describe (Amer. Pat. 1,253,252, of Jan. 15, 1918) a new class of vat dyes of interesting properties.

Dr. Kardos, in a patent issued a year ago (Amer. Pat. 1,216,134) showed that a green vat coloring matter can be secured by fusing with caustic potash at 200° to 230°C. anthracene 1.9—dicarboxylic acid imide. This compound:



is derived from aceanthrene quinone oxime, which, in turn, results from the action of hydroxylamine on aceanthrene quinone.

In the patent just issued the reaction with the caustic alkali is extended to derivatives of the above compound containing hydroxyl or a hydrocarbon radical in the imide group. More specifically use is made of the methyl-imide, obtained by the action of methyl-amine, $NH_2.CH_3$, on the anhydride of anthracene—1.9—dicarboxylic acid. The formula is:



To obtain the dye, introduce 3½ parts of the imide into 17 parts of molten potassium hydrate, while maintaining a temperature of about 210° C. and continue stirring for some time at this temperature. Then take up the melt with water, pass air through the liquid until the hydro-compound of the coloring matter has been oxidized and complete the precipitation, if necessary, by means of common salt. Filter off the coloring matter, wash it with hot water and alcohol and dry it. If desired, it can be still further purified by extraction with boiling glacial acetic acid. It yields a red-brown solution in concentrated sulfuric acid and from a red-violet vat colors cotton red-violet shades which, in the air, and more especially upon treatment with boiling soap solution, are converted into shades of a beautiful blue-green, which possess an excellent fastness against the action of chlorine.

In a similar manner analogous coloring matters can be obtained from the phenylimide of anthracene-1.9-dicarboxylic acid (obtainable from aniline and anthracene-1.9-dicarboxylic acid anhydride) and from the hydroximide (obtainable from hydroxylamine and anthracene-1.9-dicarboxylic acid anhydride).

Similar results can be secured by methylating the dye obtained from the unsubstituted imide. The following are the directions:

Place in a reflux apparatus 200 parts of water and 2 parts of the coloring matter obtainable by heating 1 part of anthracene-1.9-dicarboxylic acid imide with 5 parts of caustic alkali and a small quantity of water at from 200° to 230° C. until the formation of the coloring matter is complete, which coloring matter has been obtained in a state of fine division by precipitation from a sulfuric acid solution. Then add 7 parts of potassium carbonate and 10 parts of methyl iodide, and boil the mixture for 10 hours, and afterward filter off and work up. The coloring matter obtained possesses a tinge of green somewhat more bluish than that of the initial material, and it is also fast against the action of chlorine.

In a similar manner the same initial coloring matter can be treated with di-methyl-sulfate, or with the methyl-ester of toluene-sulfonic acid in the presence of caustic alkali, preferably at the temperature of from 60-80° C.

Boil together for 3 hours in a reflux apparatus, 2 parts of calcined soda, 2 parts of the methyl-ester of para-toluene-sulfonic acid, 120 parts of nitrobenzene, and 2 parts of the initial coloring matter referred to above. When the mixture is cold, filter off the product, and free it from nitrobenzene, and from impurities which are soluble in water. The coloring matter, when dry, is a crystalline powder and appears identical with the coloring matter obtainable from the methyl-imide of anthracene-1.9-dicarboxylic acid as described above.

In this example the nitrobenzene can be replaced by trichloro-benzene, or nephathlene.

As compared with the non-methylated dye, the shades of green obtained are of a more bluish tint. The fastness to chlorine is also increased.

The method of dyeing is identical with that used for the indanthrene and other standard vat colors.

New Phenolic Bodies for Use in Tanning

A. Schmidt and A. Andres of Ludwigshaven, Germany, assignors to the Badische Anilin—u. Soda-Fabrik (Am. Pat. 1,254,364, of January 22, 1918), have invented a new tanning material, the sulfonated condensation product of two or more molicules of phenol joined together by acetaldehyde.

The new compound is a free acid, non-crystalline and very soluble in water.

Directions for its preparation are as follows:

Shake together for some time, 94 parts of phenol, 22 parts of paraldehyde, and a small quantity of concentrated sulfuric acid. As reaction takes place heat is evolved, and care should be taken that the temperature does not rise above 90° C. When the reaction is complete, add 100 parts of 97% sulfuric acid and stir, while warming gently, until the reaction product is soluble in water.

For the purpose of tanning, take a concentrated solution of this compound, partially neutralize it with caustic soda solution and then dilute it with water until a solution of 2½° Baumé is obtained. Then add ten grams of common salt to each liter of this solution and employ it for tanning. Leather is obtained which, after being treated with fat, is of good quality and possesses a good resistance to tearing.

Formulas for German Dyes

There has been no little space devoted in the press of late to the statement that somebody in Switzerland had secured possession of over 250 recipes for the manufacture of important German dyes, and that the same had been placed in the hands of color producers.

Many are under the belief that the manufacture of artificial dyes is based upon methods which are carefully kept secret by the German makers. This is, however, far from the case. As a rule, all essential features are carefully protected by patent claims, the details of which are available to the public. Several thousand patents for artificial colors have been issued by the United States Patent Office, chiefly to German inventors, and a printed copy of any patent can be obtained for five cents.

While apparently, and technically, such a patent should reveal all that is needed for an intelligent chemist to reproduce the inventor's results, as a matter of fact the great majority are so skillfully composed and worded that it is by no means an easy matter to ascertain from their contents how to make a given dye.

In the first place there is no mention by name, in a patent, of the color or colors known to the trade, which are placed under protection. While this circumstance offers certain difficulties to the tyro in dyestuff production, it is a matter of slight concern to the large companies engaged in this branch. All new colors are promptly subjected to a most careful laboratory examination, and the relations to patents are fully established. Investigations from the scientific standpoint are also made in the laboratories of universities and technical schools, and gradually a certain literature is created in connection with a color of prominence.

From neither of these sources, however, comes the exact information as to the method in practical use by a company for the most economical production by it, on a large scale, of a given dye, nominally associated with a published patent. The latter may be very broad in its terms, covering several classes of reactions, and the use of numerous materials of closely allied nature. Thus a patent may specify, for the production of a certain class of colors, the use of aromatic amines or their homologues or derivatives. Certain illustrative examples may be given. They may contain no allusion to the actual coal-tar compound employed in making the dye in question, or the chemicals with which it reacts. There are scores or hundreds of possibilities covered by the working of the patent. An exhaustive analytical study may throw more or less light upon the question of the coal-tar intermediates employed, and yet give no indication as to the chemicals used for oxidation, reduction, condensation, etc.

Again, the question of materials may be comparatively simple, and the requisite information may be clearly given in the patent. The latter may fail, however, to furnish the needed data upon relative quantities, time required, temperatures to be maintained, and other data of a physical nature.

It is highly probable that the "recipes" secured in Switzerland refer to the accumulated experience in this latter field, concerning the production of staple dyes, which may have been gained through a long series of years by some one of the German color firms.

In regard to the older dyes, the triphenylmethane colors, most of the azo colors, the eosin class, etc., chemists now know pretty accurately just what intermediates are employed and in what quantities. It is, however, inevitable that any firm, engaged for a long time in the production, has perfected numerous minor details of treatment, which result in a lower cost of production or a more perfect adaptation to specific demands on the part of consumers.

The possession of such knowledge is not indispensable, in the building up of the dyestuff industry in another country. The essential tinctorial values of the overwhelming majority of standard, staple dyes can be duplicated, in this land for example, without great difficulty. Quick-witted American chemists would rapidly improve upon known processes in this field, as they do in others,

It is in the coming contest for holding the domestic market, and for gaining foreign markets, that the possession of such detailed knowledge as is outlined above would prove of great value. More or less information of this character is constantly being secured by American manufacturers of colors as they engage chemists of experience in foreign dye works (Swiss in most cases), each of whom possess a tolerable range of familiarity with a limited number of colors. Not infrequently such chemists are restricted by formal contract provisions from communicating information gained during connection with a given firm. Despite such provisions, the information is bound to become eventually known.

A year ago there was a chemist in Switzerland who had been for a number of years at the head of the French factory of a leading German color company. After the works had been commandeered by the French government and he was retired, he was quite ready to consider an American engagement, based upon his intimate knowledge of the manufacture of a large variety of dyes. It is possible that his repertory forms the basis of the statements referred to above.

German Patents

Active use is now being made in England of the right to employ German patents for the manufacture of coal tar colors. The leading company, British Dyes, Ltd., has applied for permission to produce lyes covered by 77 patents. These latter concern chiefly vat dyes obtained from anthraquinone derivatives, but include also a number of important azo colors, as well as sulfonic dyes in other groups, especially those producing black, brown and blue shades.

In this country regulations have been formulated by the Federal Trade Commission under which patents owned by enemy aliens can be licensed for manufacture by American citizens.

These regulations issued Oct. 30, follow the law closely in safeguarding the interests of patent owners, who must be reimbursed for the use of their inventions, and provide that licenses will be issued only where the interest of the public demands it, to supply a demand not now being met. The licensee must prove his ability to make the article.

Licenses are to be granted for the life of the patent and not merely for the duration of the war, and this is in direct acquiescence to an objection proposed by the dye interests that it would be prohibitive to have to go to the expense of installing costly machinery if they would have to surrender rights to make the dyes after the war. Exclusive licenses are not to be granted to individual firms. The licensee will be required to file with the Federal Trade Commission a semi-annual report of business done.

The use of trade-marks, copyrighted labels and similar trade devices will be granted in exceptional circumstances in connection with the use of the patents.

When the commission will issue licenses for manufacture of articles patented by enemy aliens or their allies probably will depend on the time required for American producers to meet the license requirements.

C. H. McDonald of Wisconsin, Chairman of the Board of Review of the Federal Trade Commission, will have charge of administering the regulations, assisted by Edward S. Rogers of Chicago and Francis J. Phelps of Washington as advisers.

Steps are being taken by our color manufacturers to secure licenses for the production of some much-needed dyes, especially the indanthrenes and other allied vat dyes.

The chief interest centers, however, about the manufacture of synthetic dyes and especially of salvarsan.

There have been many conferences between the Federal Trade Commission and prominent chemists and physicians in regard to the conditions under which permits will be issued. It is highly probable that the Commission will maintain a strict control over output, distribution and price, and that, in the case of synthetic drugs, a certain proportion will be available for military and public health needs.

In the case of artificial colors it would seem to be a matter of prime importance that our manufacturers become familiar as soon as possible with the details of the production of a group of valuable dyes, chiefly sulfur and anthracene colors, the patents of which expire during the next few years. Under existing conditions the preliminary experience can be gained at slight cost. When peace returns, and when a little later the manufacture is free to all concerned, it will be comparatively easy to maintain the output on a basis of cost of production low enough to meet foreign competition.

It is not to be forgotten, also, that the broader our grasp of knowledge of varying operations, the stronger will be our hold on the general situation, and our ability to lower costs of manufacture so as to effectively ensure the continuance of the domestic output of individual products.

One great source of power in a German dyestuff company is the ability to concentrate the experience of a large group of talented chemists on any current problem. Each one contributes from his own special field a helpful idea and aids in simplifying the final solution.

For this reason it is eminently desirable that the American coal tar chemical industry should utilize the present opportunity to make as large a circle of chemists as possible thoroughly intimate, by practice, with all the recent progress in branches which have hitherto been completely closed to us.

Much interest attaches to the recent announcement by Dr. Flexner before the National Academy of Science, that he has obtained a substitute for salversan, equally effective, but costing one-fiftieth of the current price of the synthetic drug.

The manufacture of the latter has now been established in this country by the American representative of the German firm owning the patent. Whatever may be the outcome of Dr. Flexner's discovery, it seems certain that we will have before long a fairly adequate domestic supply of salvarsan, available, however, at a high price. It is authoritatively stated that the drug can be sold with profit at $1.00 per unit, as compared with $25 which has been exacted of American consumers.

Some 20,000 valid patents are affected by the new regulations.

Electrochemical Synthesis of Aromatic Hydrocarbons

At the meeting of the American Electrochemical Society, held at Pittsburgh Oct. 3, Louis B. Cherry described the results obtained so far in exposing mixtures of methane or hydrogen and some of the heavier hydrocarbons of petroleum to the action of high-frequency currents. Experiments have been conducted in systems of pipes, one inch in diameter and 10 feet in length. Each pipe contains a fine platinum wire passing through the center and connected with a high-frequency coil conveying a current of over 100,000 volts. As a result, a silent electric discharge alternates back and forth between the central electrode and the pipe. These treatment pipes are heated by induction, being wound with copper cable. Natural gas and vapors of kerosene (42.5° Bé.) were passed through the pipes under ordinary pressure and under high pressure. It was found that without resorting to additional pressure, 78 per cent. of the kerosene could be converted into gasoline of 65° Bé. No carbon is deposited in connection with the conversion at temperatures below 480° C.

Plans are now under way to put the process into economic operation by attaching the apparatus to petroleum refineries in regions where natural gas is available. During distillation the proper fractions of oil vapors would be delivered into the treatment pipes or chambers.

Naturally it has been considered possible that modifications of the process might permit of the formation of aromatic hydrocarbons. Preliminary experiments in this connection indicate favorable results. Oil vapors, without an admixture of natural gas, under a pressure of 5½ atmospheres and at a temperature of 538° C., when passed through the apparatus, yield a distillate consisting largely of benzone and toluene. These experiments are being continued and may possibly result in opening up a new source of toluene which will be extremely welcome at present.

Mr. Cherry assumes that the ionizing effect of the heated tubes, combined with the effect of the high-frequency current, brings about a double reaction, disorganizing the gases and oil vapors and simultaneously reorganizing the molecules without causing any separation of carbon or other elements.

German Dyestuff Companies

We have had occasion to refer to the extensive preparations made by the great German dyestuff companies to reconquer, on the return of peace, the territory now commercially lost to them. The six largest companies pooled their interests for this campaign a year ago, and will act as a unit. They have all announced notable increases of capital. In the cases of the "Badische," "Bayer" and the Höchst Farbwerke, the individual increases are from about $13,500,000 to $22,500,000. The German Government has practically promised them subventions, if necessary, to enable them to win back the lost trade.

One of the important factors in the situation, the works of the Griesheim Company near Frankfort, were practically wiped out of existence on Nov. 22, by a terrific explosion. It is considered impossible to reconstruct the works during the war. Like all the other great coal-tar chemical works, the company at Griesheim was devoting its energies chiefly to the production of munitions. Its loss will very materially affect the current supply for the German army.

London advices give the following data on the extent of the operations of this plant and picture conditions quite similar to those existing in the plants of the "Badische" and other leading companies:

"The explosion caused the complete destruction of one of the greatest munition factories in the world. Germany suffered a disaster comparable to a very serious military defeat in its effect on the war.

"The Griesheim factory consisted of a group of buildings covering over fifty-four acres. Before the war it ranked as fourth in importance among great German chemical works, and was flourishing, the company paying a pre-war dividend of 14 per cent. and being worth as a going concern well over 60,000,000 marks.

"Its commanding position in the chemical world rested not only on its huge output, but also on the extensive variety of its manufactures. These comprised, among other things, aniline dyes of every description, nitric, sulfuric, and other acids, phosphorus and alkali, with liquid chlorine, hydrogen and oxygen as important by-products.

"Moreover, it was of prime importance as a source of synthetic nitrates, and its splendidly organized research laboratory enabled it to play a leading part in the production of poison gas and other forms of frightfulness which Germany has introduced in the course of the war.

"The Greisheim concern has been producing saltpeter for the manufacture of black powder at the rate of 1,000 tons daily, and it was reputed to be the only factory turning out this article. To such an extent had its already impressive output of nitrate and sulfuric acid been developed that it supplied the whole demand of five nitroglycerin and dynamite factories, as well as of two powder works, including that of Rottweil, one of the most important in Germany.

"Another explosive which was manufactured in large quantities was tonite, through its facilities for making synthetic phenol, and consequently picric acid, from which acid this explosive is derived.

"Another circumstance of interest is that this factory supplied quantities of electrolytic hydrogen for the inflation of Zeppelins, and possesed by way of a reserve three gasometers with a total capacity of over 300,000 cubic feet. The electrolytic plant was further utilized to produce asphyxiating gas and lachrymatory and poisonous shells. In fact, it is the greatest center of this manufacture in Germany, and in 1916 the output of poison gas reached nearly 600,000 cubic feet daily.

"Every concern in Germany is affected both by the cutting off of supplies which many of them formerly drew from Greisheim and by the necessity of making the loss of these supplies good from plans already working to the maximum. The death of scores of trained workmen and specialists in the factory itself and the dwellings within its confines will make the task of coping with this deficit all the more difficult."

The corporate name of this company is "Chemische Fabrik Griesheim-Elektron." Numerous synthetic dyes have been discovered in its laboratories and placed upon a manufacturing basis.

The Physical Basis of Color

The fundamental reasons for the phenomena of color are constantly being subjected to investigation.

In a recent issue of the "Färberzeitung" the connection between size of molecule and tinctorial results is made the subject of study. The following paragraph summarizes the conclusions:

"Whtenever a dyestuff is affected by light, the cause is to be found in the absorption of a part of the light rays by the dyestuff, resulting in an oscillation of the molecule. A dyestuff which produces a bright fast color is characterized by a molecule which is not greatly influenced by the amplitude of vibration of the penetrating waves of light, consequently the intensity of the transmitted or diffused and the absorbed light waves is only slightly diminished. In the case of dull and fugitive colors the amplitude of the chemically

(*Concluded on page* 236.)

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By CARLETON ELLIS and A. A. WELLS.*

PART XIII

Trinitrotoluene.

Custis reports the following experiments on trinitrotoluene. The compound was placed in a capillary tube made of quartz. This tube was kept in the path of the rays emanating from an iron arc which was placed 1.5 centimeters from the tube. After six hours' exposure the product was examined. It had turned a dark brown and had a melting-point of 79.06°.

Samples of trinitrotoluene, melting-point 80.47°, were placed, one in a capillary tube made of quartz, and another in a capillary tube made of glass. These tubes, together, were placed on a table 7 centimeters from a mercury quartz lamp. The heating effect of the lamp on the tubes was greatly reduced by employing a mechanical blower, so arranged as to drive a constant stream of air over the tubes. The temperature indicated by the thermometer was 30° at the beginning and 40° at the end of a three-hour period. After an exposure of the above duration the samples were examined. There appeared to be no darkening of the crystals in either tube. The melting-point of both specimens was found to be the same, namely 80.21°. This identity in the change of melting-point in samples contained in glass and quartz, and exposed to the rays from a mercury quartz light, seemed surprising. The experiments indicate that artificial light materially affects trinitrotoluene, and that the long ultra violet rays (i.e. those which can pass through 7 centimeters of air) have little, if any, greater effect than the "visible" rays from a mercury quartz arc. The change in this nitro compound is stated to be due to oxidation.

Esterification by Ultra Violet Light.

Stoermer and *Ladewig* (Ber. 1914, *47*, 1803,) have accidentally discovered that, when alcoholic solutions of trans-cyclopentane 1:2-dicarboxylic acid are exposed to ultra violet light (Uviol lamp) conversion into mono- and di-esters occurs. The expected transformation into the cis-modifications did not occur. Benzoic acid is also esterified under these conditions (30 per cent. in 8 days) and the reaction is still further promoted by the presence of a trace of hydrochloric acid (56 per cent. in 8 days). Cinnamic acid is scarcely affected without the addition of a trace of hydrochloric acid, but the yield of ester may then reach 37 per cent. in 8 days. The methyl esters of these acids were thus produced.

Oxidation of Aromatic Hydrocarbons.

The fact that the most easily isolable products of the autoxidation in light, of benzene homologues, are carboxy-acids is attibuted by *Suida* (Monatsh, 1912, *33*, 1255) to the relative instability of the intermediate products. The most satisfactory source of light was a quartz lamp, used at a distance of about 10 centimetres from the specimen of substance. The velocity of the first stage of the oxidation could be approximately measured by the amount of peroxide formation; this was estimated by the action on a solution of potassium iodide acidified with dilute sulphuric acid with titration of the liberated iodine some hours afterwards. The parallel formation of carboxylic acids was estimated previously by titration with N/30-potassium hydroxide solution; it appears that the amount of acid formed cannot be entirely due to the decomposition of the peroxide.

The results indicate that pure benzene is practically passive but that the presence of thiophen causes peroxide formation. Methyl substituted benzenes undergo autoxidation when illuminated, and the action is accelerated by the presence of small quantities of nitrobenzene or of one of the nitrotoluenes. The oxidation of xylene occurs more than twice as rapidly as that of the toluenes, and p-xylene, oxidizes more rapidly than the ortho-isomeride. The oxidation of 4-nitro-m-xylene under the influence of light resembles that of p-nitrotoluene, but is feebler.

Organic Peroxides.

In endeavoring to oxidize benzaldehyde in the presence of oxygen, directly to benzoyl hydroperoxide, *Suida* (Ber. 1914, *47*, 471), used a Heraeus quartz lamp. A current of oxygen was passed through benzaldehyde in petroleum ether and the solution was exposed at a distance of about 2 cm. from the burner. The vessel in which the benzaldehyde was exposed was cooled with ice. During an exposure of 6 hours a considerable quantity of benzoic acid formed, together with small quantities of a peroxide body. On cooling the vessel by means of solid carbon dioxide and ether the formation of the peroxide was much increased. A white deposit was slowly obtained which had strong oxidizing properties and a pungent odor. The peroxide substance could not be isolated readily on account of rapid conversion into benzoic acid. At the same temperature, but with the exclusion of light there was no indication of formation of the peroxide body.

Benzaldehydephenylhydrazone does not redden at all, even on prolonged exposure to the air, if light is excluded. (Chattaway, J. Chem. Soc. Trans. *89*, 1906, 463). In light, its color alters in a remarkable way; in diffused light, reddening takes place slowly, but in sunlight the change becomes very noticeable in a few minutes and the color quickly deepens until after a few hours a maximum intensity is reached, when the crystals have a brilliant scarlet color resembling that of azobenzene. The light from an electric arc playing between iron poles, which is extremely rich in ultra violet rays, also brings about the change, the velocity of which falls off in the ordinary way as the distance from the arc is increased. Exposed in a quartz tube at a distance of five cm. the change was about as rapid as in direct winter sunlight. The transformation, however, appears not to be due to ultra violet rays, as its rate is not affected by interposing a sheet of ordinary crown glass.

---

*All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

Reduction of Ketones.

The reduction of an aromatic ketone in a perfectly neutral medium does not proceed any further than to the pinacone, according to *Boeseken* and *Cohen* (Proc. K. Akad. Wetensch, Amsterdam, 1914, 17, 849; J. Chem. Soc., 1915, Abs. 108, ii, 37). A series of ketones dissolved in a great variety of anhydrous alcohols and a few other substances have been exposed to the light of a mercury lamp; in all cases where reduction occurs not a trace of the hydrol is formed, the ketones being quantitatively changed to the pinacones. The addition of sodium ethoxide to the alcoholic solution results in the formation of the hydrols, as is to be expected. The conclusion is reached that in the reduction of aromatic ketones the hydrogen unites exclusively with the oxygen; the resulting half-pinacone polymerises to the pinacone, and the latter, in the presence of hydroxyl ions is transformed into an equal molecular mixture of the ketone and the hydroxyl.

Quinine.

A study of the reaction between chromic acid and quinine in light has been made by *Goldberg* (J. Chem. Soc., 1906, Abs., ii, 514) whose results seemed to indicate that the velocity was dependent on the quantity of light absorbed by the chromic acid. *Luther* and *Forbes* (J. Amer. Chem. Soc., 1909, 770) have found, however, by means of monochromatic light that the quinine is the substance which is sensitive to light, while the chromic acid only acts as an indifferent light filter, absorbing a part of the light and converting it into heat. Determinations of the initial velocities of the reactions induced in solutions by monochromatic light have been made, and the quantities of light absorbed by the quinine and chromic acid have been calculated from measurements of extinction coefficients. The concentrations of the reacting substances, the intensity of the incident light, and the wave-lengths of the light were varied, one at a time, in successive experiments. The source of light was a uviol mercury vapor lamp, and a series of light filters were employed. It was found in preliminary experiments that the total reaction velocity was proportional to the concentration of the hydrogen ion. The photochemical reaction is exactly the difference between the total reaction and the spontaneous reaction of the same mixture in the dark, and the combined effect of two rays is additive. The speed of the photochemical reaction is proportional to the quantity of light of given wave-length absorbed by the quinine alone unless the concentration of the chromic acid is very small. It is probable that the reaction takes place in two stages: (1) the formation of sensitized quinine with a velocity proportional only to the light absorption, and (2) a reaction in ordinary sense, between this product and chromic acid with a velocity proportional to the concentration of the chromic and sulphuric acids.

Nicotine and Pyridine.

The effect of ultra violet rays on nicotine and pyridine have been studied by *Custis* (J. Frank. Inst. 1917, 878), who found that ultra violet radiation produces a change in nicotine solutions. A one-tenth per cent. solution of nicotine when exposed in a quartz flask at 5 centimeters from a source of ultra violet light for 15 minutes showed a decided decrease in nicotine content. A 40 per cent. solution of commercial nicotine, when exposed for 30 minutes at 5 centimeters from an iron arc showed an increase in the amount of nicotine present. Custis explains this increase in the second sample on the grounds that commercial nicotine contains impurities in the form of certain oils and it is not unlikely that nicotine was synthesized from these oils.

Turpentine.

Dedichen and *Halse* (U. S. patent 1,253,793, Jan. 15, 1918) expose raw turpentine oil to the action of ultra violet rays while subjecting it to the action of air or oxygen. The oil is then treated with iron chloride to refine and deodorize it and obtain a mixture of α and β-pinenes containing dextro-rotary β-*pinenes*.

Phenyl Vinyl Acetic Acid.

As a representative of the β, λ. ethytenic acids λ phenylvinylacetic acid in benzene solution was exposed to ultra violet light by *Stoermer* and *Stockmann* (Ber., 1914, *47*, 1793). The acid resinified to a considerable degree. Although the allo-form could not be obtained in crystalline form, the crystalline allo-amide was isolated and converted by illumination into the stable variety.

Chlorination of Acetic Acid.

The effect of ultra violet light on the chlorination of acetic acid has been investigated by Custis (J. Frank Inst., 1917, 874). Glacial acetic acid was placed in a quartz flask fitted with a reflux condenser and heated on a steam bath. Chlorine was passed into the flask and subjected to the influence of the rays from an iron arc at a distance of 3 centimeters, giving monochlor acetic acid. The use of red phosphorus as a catalyzer improved the yield. If, however, the flask was placed under the influence of rays from an ordinary projection lantern at about 5 centimeters, the other conditions being the same, no chlor acetic acid was obtained. No results were obtained by passing the chlorine gas through a quartz tube which was illuminated with ultra violet rays before being passed into a non-illuminated flask containing glacial acetic acid.

Custis (J. Frank. Inst., 1917, 875) has also investigated the effect of ultra violet light (iron arc) on the chlorination of benzene and toluene. At room temperature no substitution products were obtained under the influence of the rays from an ordinary projection lantern, but when exposed to ultra violet rays chlorinated products were obtained. Toluene was chlorinated under similar conditions by passing chlorine which had been activated by ultra violet rays before being passed into a non-illuminated flask of toluene. Benzene could not be chlorinated in this manner.

Oil Hardening.

A process of hydrogenating oils involving exposure of the oils as a film on a web carrying catalytic material and at the same time exposing the oil and catalyzer to the rays of an ultra violet light has been proposed by *Walter* (Hydrogenation of Oils, New York, 1914, 34; Seifen. Ztg. 1913, 442). One form of apparatus described by Walter for carrying out this reaction consists of a closed vessel in which is placed a belt or web carrying catalytic material. The belt may be made of asbestos or cotton cloth and may be impregnated with platinum, iridium, nickel or other catalytic material. The belt is carried on rollers, one of which dips into the oil. Catalyzers also may be carried in a container attached to the belt. The ultra violet lamp is located in the closed vessel, thus illuminating the interior.

Utescher (British patent 20,061, Sept. 3, 1912) treats oils with hydrogen in presence of a finely-divided catalytic agent, and at the same time the material is subjected to the action of a silent electric discharge, which it is stated is prevented from coming into actual contact with the fatty substance, the chemically active rays only being utilized. It is also stated that the process may be effected by allowing the rays to impinge on the surface of a catalytic substance which may be used in the form of plates.

Testing Hydrogenated Oils.

Ultra violet light may be used as a qualitative test in some cases for the detection of unhydrogenated oils in hydrogenated oils or fats. A well-hardened hydrogenated oil, such as hardened cottonseed oil of a melting point of about 60° C., is very resistant to the action of ultra violet light, while the cottonseed oil from which it is prepared is quite readily thickened by the effect of the ultra violet waves. Accordingly, a mixture of the two glycerides changes in appearance on exposure to ultra violet light. Many ordinary greases or fats such as soapmakers' tallows and the like are darkened and polymerized on exposure to ultra violet light, while hard fat of the melting point referred to is scarcely visibly changed. An exposure of several hours at a distance of 4 to 8 inches from the burner is recommended.

Gas Analysis.

The application of ultra violet light in the analysis of gases is suggested by *Landau* (Compt. rend., 1912, *155*, 403; J. Chem. Soc., 1912, Abs., *102*, ii. 986). Ethylene is slowly polymerized by light from a mercury lamp of 110 volts, but the action is incomplete even after 134 hours. With a 500-volt mercury lamp, polymerization is complete, both for ethylene and acetylene. Ethane and methane are not affected by ultra violet light, but in the presence of excess of oxygen the former is eventually completely oxidized to carbon dioxide and water. Carbon monoxide in presence of oxygen is also slowly, but completely, oxidized to carbon dioxide. Landau suggests that the analysis of mixtures of hydrogen ethylene, and ethane might be accomplished by the use of ultra violet light.

Carbon Dioxide.

By the action of ultra violet light on dry carbon dioxide, *Chadwick, Ramsbottom* and *Chapman* (Proc. Chem. Soc. 1906, 22, 23) succeeded in partially decomposing the gas into carbon monoxide and oxygen. No determination of ozone was made. With moist carbon dioxide no decomposition occurred. The peculiar influence of water vapor is believed to be due to the action which it exerts on the vibrations of the electrons of the gases.

Ammonia.

Coehn and *Pringent* (Zeitsch. Elektrochem. 1914, 20, 275; J. Chem. Soc. 1914, Abs. *106*, ii, 404) have endeavored to ascertain whether the decomposition of ammonia is complete or whether a determinable amount of ammonia remains undecomposed. Ammonia was sealed up in quartz tubes and exposed to the light of a quartz mercury lamp, and the gas examined after various periods of exposure. It was found that after one hour ammonia was still present, but after six hours ammonia could not be detected by means of Nessler's reagent, thus showing that the decomposition was complete. Weigert (J. Chem. Soc. Abs., 1908, ii, 5) has shown that when a mixture of nitrogen and hydrogen is sensitised by the addition of chlorine, ammonia is formed by ordinary visible light. Coehn and Pringent have passed similar mixtures, dry and damp, through a quartz tube, which passed down the centre of a quartz mercury lamp, and have been unable to show the formation of ammonia even in such small amounts as would give the reaction with Nessler's reagent.

Properties of Phosphorus.

When a strong current of air is drawn through a solution of phosphorus in paraffin, the resultant glow shows a continuous spectrum in the visible region. With the aid of a specially constructed "phosphorescent screen" and an exposure of 95 hours, *Centnerszwer* and *Petrikaln* (Chem. Abs. 1912, 3355; Z. Physik. Chem., 80, 235-40) succeeded in photographing the ultra violet region. They found sharply defined lines and a band in the neighborhood of 3252° A, indications being that this band is composed of separate lines.

Though there is strong absorption in the ultra violet, there were no visible lines or bands. In an investigation of the reported effect of radiations from phosphorus on a photographic plate wrapped in black paper it was found that when the oxidation products were removed as fast as they were formed, the plate was not affected, indicating that the effect was due to some volatile oxidation product, presumably hydrogen peroxide.

Calcium Carbide.

Calcium carbide was exposed to the action of ultra violet rays by Custis (J. Frank. Inst. 1917, 880). There was apparently no reaction as no pressure was built up and the tests for ammonia in the treated product gave negative results.

Chloroplatinic Acids.

A comprehensive study has been made by *Boll* (Ann. Physique, 1914 (ix), 2, 54, 266; J. Chem. Soc., 1915, Abs. *108*, ii, 123) of the photochemical decomposition of chloroplatinic acids in very dilute aqueous solution, and some observations relating to the decomposition of oxalic acid in presence of uranyl nitrate are also described. The progress of the photochemical reaction was determined by measuring the accompanying increase in the electrical conductivity of the solution. In a series of experiments, in which the solutions were exposed to the light rays emitted by a mercury quartz lamp, it was found that the photochemical decomposition of all the chloroplatinic acids proceeds in agreement with the formula for a bimolecular reaction. In all cases the reaction is practically complete, and from the observed differences between the final and initial conductivities it would seem that two molecules of hexa-, penta-, tetra-, di- and mono-chloroplatinic acid give rise respectively to 11, 9, 7, 3 and 1 molecules of hydrochloric acid. The solutions, which are obtained when the photochemical decomposition has run its course, are metastable, and as a general rule deposit a reddish-brown precipitate of platinic hydroxide. Experiments with tetrachloroplatinic acid, in which the solutions were subjected to the influence of monochromatic ultra violet light (λ 2536 and λ 2655) have shown that the reaction velocity is proportional to the intensity of the incident radiation. The photochemical decomposition of the chloroplatinic acids can be made use of in the construction of a chemical actinometer covering a range which extends from the yellow to the extreme ultra violet.

Oxalic Acid.

The experiments relating to the photochemical decomposition of oxalic acid indicate that this reaction is unimolecular, and from the total change in the electrical conductivity Boll (J. Chem. Soc. 1915, Abs. *108*, ii, 123) draws the conclusion that the chemical reaction corresponds with the equation $H_2C_2O_4 + O = 2CO_2 + H_2O$. Uranyl nitrate in the solution acts as a catalyst. In agreement with the observed unimolecular character of the reaction, it is found that the velocity is proportional to the quantity of light absorbed by the solution, and that this proportionality is independent of the concentration of the oxalic acid.

The decomposition of oxalic acid by uranium and its compounds has been investigated by *Landau* (Compt. rend. 1913, 156, 1894) and shown not to be parallel with the radio-activity of the substances used. The lightest and heaviest metal of each of six groups of the periodic table were also tried in the form of nitrates, and of these only chromium and uranium (group VI) proved to be active, uranium being three times as active as chromium. A mercury lamp was used as the source of light.

Mercuric Oxalate.

According to *Winther* a solution of mercuric oxalate completely free from iron would be photochemically inactive. The fact that this conclusion did not agree with Eder's observations (Zeitsch. wiss. Photochem., 1914, 14, 172; J. Chem. Soc., 1915, Abs., 108 ii, 199) has led to a further series of experiments with solutions prepared from carefully purified substances. These experiments show that the photochemical sensitiveness of solutions of mercuric oxalate (mercuric chloride and ammonium oxalate) is not dependent on the presence of traces of ferric salts, but is also exhibited by the pure mercuric compound. The decomposition of the mercuric salt is mainly determined by the ultra violet rays, but comparative observations have shown that the relative activity of the visible rays is increased if the solution contains small quantities of iron.

The precipitation of mercurous chloride from Eder's solution, on exposure to light, reaches a limit when the solution still contains large quantities of mercuric chloride and ammonium oxalate. Comparative experiments by *Winther* and *Howe* (Zeitsch. wiss. Photochem., 1913, 13, 89; J. Chem. Soc. 1914, Abs. *106*, ii, 10) in which equal volumes of the filtrate and of a fresh solution of the same composition were exposed to the influence of light under similar conditions, indicate that the initial photochemical action leads to the formation of some substance which acts as a powerful negative catalyst. The same phenomenon is met with in the case of Eder's solution to which eosin is added. In general, the effect becomes more marked as the intensity of the light increases. If the ultra violet rays are cut off during the preliminary exposure, the photochemical sensitiveness does not disappear. Further, it has been found that there is an appreciable loss of sensitiveness if the eosin solution is insolated before adding to the Eder's solution. The observations seem to show that the anti-catalyst which reduces the photosensitiveness of the solution is a product of the photochemical decomposition of eosin.

Ferrous and Mercuric Chlorides.

The rate of reduction of mercuric chloride by ferrous chloride under different conditions has been examined in some detail by *Winther* (Zeitsch. wiss. Photochem., 1912, *11*, 60). When the concentration of the mercuric chloride is constant and relatively small, the rate is nearly independent of the concentration of the ferrous salt. For a given concentration of the latter, the rate increases at first with the amount of mercuric chloride and then diminishes. The maximum appears to be attained when the two salts are present in equimolar quantities. In the case of solutions containing small quantities of mercuric chloride relatively to ferrous chloride, the sensitiveness increases with the dilution, but this is not the case for solutions containing equimolar quantities. Such solutions do not vary to the same extent when the concentration is changed, and the maximum sensitiveness is shown by solution containing the two salts in 3-molar concentration. The presence or absence of oxygen is without appreciable influence on the equimolar solution, but oxygen reduces the quantity of mercurous chloride obtained when a large excess of ferrous chloride is present. The most active light rays are those of wave-length less than 265 $\mu\mu$, as is shown by comparative experiments in quartz, uviol glass, and ordinary glass vessels.

Iodine.

An apparatus is described by *McLennan* (Proc. Roy. Soc., 1913 (A.), 88, 289-296; J. Chem. Soc., 1913, Abs., ii, 455) by means of which it has been possible to subject iodine vapour to intense illumination by light of wave-length extending from beyond $\lambda = 700$ $\mu\mu$ down to $\lambda = 185$ $\mu\mu$. The apparatus consists of an outer glass illuminating tube of ordinary Cooper-Hewitt type, and an inner tube of clear fused quartz, which is sealed into the former by wax joints. The outer tube is furnished with mercury electrodes, and carries the mercury arc, whilst the inner tube, after the introduction of crystals of iodine, is exhausted and sealed off.

The fluorescence spectrum, which is exhibited by the iodine vapour under these conditions, is characterized by the presence of a large number of narrow bands extending from about $\lambda = 460$ to about $\lambda = 210$ $\mu\mu$. More than eighty such bands have been recognized on the photographic records, and the mean wave-lengths of these are recorded. When the inner quartz tube is replaced by a similar tube of glass, the band spectrum disappears. From this it is inferred that the emission of the banded spectrum is not due to the elevated temperature of the vapour in the tube, but is a true resonance or fluorescence effect. The fact that the glass tube inhibits the banded spectrum indicates further that the exciting light consists of short-waved rays, which are absorbed by the walls of the glass tube. Further observations by McLennan (Proc. Roy. Soc. 1914 (A), *91*, 23; J. Chem. Soc. 1914, Abs. *106*, ii, 829) show that the spectrum is excited at all temperatures between that of the room and 1000°. It is called forth when the wave-length of the exciting light falls between the limits λ 2100 and λ 1800. On the other hand, reasonance spectra cannot be obtained when the iodine vapour is illuminated by light from a mercury arc of wave-length less than that of the green line λ 5460. The investigation of a number of iodine compounds has shown that iodoform and mercuric iodide give a fluorescence spectrum which contains the seven well-marked bands of the iodine fluorescence spectrum between λ 3315 and λ 3175. In addition to the iodine lines, the mercuric iodide spectrum contains a number of specific bands which are absent from the iodine spectrum. With potassium iodide, a fluorescent spectrum is obtained which does not show any of the iodine bands. It consists of two sets of unequally spaced fine lines in the regions between λ 4047 and λ 3340 and between λ 3075 and λ 2940.

Iodides.

It has been observed by *Ross* (J. A. Chem. Soc. 1906, 788) that when a solution of potassium iodide is exposed to ultra violet light (produced by a spark between aluminum terminals) the exposure being made in an open vessel, the amounts of iodine set free, on making exposures for equal intervals of time, varied greatly. When the distance of the solution from the spark was doubled, the rate of decomposition remained almost the same as before. The spark was then made to pass through an atmosphere of oxygen. This was done by placing the terminals in a large bell jar filled with the gas. Under these conditions, the rate of decomposition was found to be very much increased. In replacing the oxygen with carbon dioxide, the amount of decomposition resulting in the same length of time was very small. It therefore became evident that the greater part of the decomposition first obtained was produced, not by the light only, but principally by the action of ozone and the oxides of nitrogen formed by the passage of the spark through air. To determine the effect of the ultra violet light only, the solution was placed in a small shallow dish provided with a quartz cover. The latter was sealed into a rim of hard rubber which was in turn surrounded by an elastic rubber band. This then could be slipped over the top of the dish so as to secure the complete exclusion of any gas. When the dish was now placed underneath the spark, the decomposition resulting represented the total effect of the waves of light given out by the spark. By subtracting from this the effect produced when a thick piece of glass plate was interposed between the spark and the solution, the effect of the ultra violet light alone, or that part of it capable of being absorbed by the glass, was determined. When a photograph of the spectrum given by the spark was taken by means of a spectroscope, it was found that with the thick glass plate interposed between the spark and the spectroscope, all wave-lengths were absorbed below λ 3260. That the decomposition of the iodide, which took place when gases formed by the spark were excluded, was due to the action of the light alone was shown by varying the distance of the solution from the spark. It was now found that the amount of iodine set free varied inversely as the square of the distance, which one would expect if the decomposition is due entirely to the amount of light energy incident upon the solution. The iodides of sodium, lithium, barium, calcium and zinc were found to give results similar to those obtained with potassium iodide.

Ross (J. Am. Chem. Soc., 1906, 786) investigated the reduction of chlorates and bromates by the action of ultra violet light and observed that while solutions of the chlorates and bromates are quite stable in sunlight, they were reduced to quite an extent when acted upon by that part of the ultra violet spectrum capable of being absorbed by glass. It was found that solutions of all chlorates of the same strength were reduced at the same rate, while the same thing was true of the bromates. The rate of reduction of the chlorates, however, differed from that of the bromates. Unlike iodides or ferric salts, varying the strength of either the chlorate or bromate solutions from ½ to 1/50 normal did not produce any appreciable difference in the amount of reduction which took place. In the case of the bromates the amount of salt reduced was less than in the case of the chlorates. Thus, when the strength of any standard bromate solution was varied from 1/2 to 1/100 normal, the amount of bromide formed in every case was equivalent to only 0.25 cc. of a 1/200 normal silver nitrate solution. The amount of chlorate or bromate reduced was found to be exactly proportional to time of exposure. Sugar added to solutions of the chlorates or bromates resulted in an increase in the amount of reduction.

Chlorates, Bromates and Iodates.

The influence of ultra violet light on alkaline salts of acids containing halogen and oxygen has been compared by *Oertel* (Biochem. Zeitsch. 1914, *60*, 480; J. Chem. Soc. 1914, Abs. 106, ii, 321). Under the action of ultra violet light the alkali salts of chlorates, bromates, iodates and periodates in aqueous solution decompose into oxygen and the halogenide, and the reaction is quantitative with a sufficiently long period of illumination. Only a very small decomposition could be observed in the case of the perchlorates. The rate of decomposition in the case of the bromates was greater than that of the iodates, and of the latter greater than that of chlorates. The amount of reaction products formed in a given time increased with increasing concentration of the solution, and the nature of the cation was without influence on the rate of decomposition. The solid substances also undergo decomposition when exposed to light, the chlorates decomposing readily, the bromates less so, the iodates being changed but very slightly.

The action of light of short wave-length on solutions of potassium iodate has been investigated by *Mathews* and *Curtis* (J. Physical Chem., 1914, *18*, 641; J. Chem. Soc. 1914, Abs. 106, ii, 830). Solutions of 0.1N-potassium iodate were placed in a quartz flask and kept at a temperature of 30 by allowing a stream of water at this temperature to flow over them. Light from a mercury vapour lamp was allowed to fall on the flash, when iodine was liberated. The amount of iodine liberated was estimated from time to time by titration with a 0.001N- solution of potassium thiosulphate. The following results are obtained: (1) When the photolysis is carried out in the presence of air, the rate of the reaction slowly decreases with time. (2) Iodine is not liberated when the solution is kept saturated with oxygen in an atmosphere of oxygen. (3) Carbon dioxide greatly increases the rate of photolysis; and (4) the rate of photolysis of potassium iodate in a solution kept saturated with carbon dioxide is linear when the amount of iodine liberated is small compared with the total amount present in the iodate. It is therefore not possible in such circumstances to determine the order of the reaction. It is suggested that the photolysis occurs according to the scheme: $KIO_3 = KI + 3O$ and $5KI + KIO_3 + 6CO_2 + 3H_2O = 6KHCO_3 + 3I_2$; the liberation of oxygen has been experimentally proved. Light accelerates the reaction between potassium iodate, potassium iodide and carbon dioxide, but the reaction is very complex in the presence of light, and has not been quantitatively investigated. A lecture experiment to demonstrate the photochemical activity of light of short wave-lengths is described. To a solution of 0.1 gram of potassium iodate in 500 c.c. of water, 2 c.c. of a 1% solution of potassium iodide and 2 c.c. of starch solution are added. One-half of the solution is placed in a quartz flask, and the residue in a glass flask. The flasks are placed at equal distances from a quartz mercury lamp, and in a few seconds the solution in the quartz flask turns blue, while the other remains quite colorless.

Absorption of Ultra Violet Rays by Ozone.

In an investigation of the transparency of the atmosphere for ultra violet radiation, *Strutt* (Nature 1917, 144) states that the solar spectrum, even when observed from a mountain top, does not extend so far as 2900, which result is attributed to absorption by ozone. Strutt has now photographed the spectrum of a mercury vapor lamp four miles distant and finds that it extends as far as the line 2536 and perhaps further. This line lies near the maximum intensity of the ozone absorption band, and therefore ozone can have nothing to do with the limit of the spectrum in this case. To reconcile the two results it is assumed that there is much less ozone near the earth's surface than at high levels.

Effect of Change in Wave Length.

Bovie (Am. J. Trop. Diseases and Prev. Medicine, 1915, 506) has made an interesting contribution to the subject of the action of light on protoplasm. He states that if the object upon which a wave train falls is capable of resonant vibration and if these vibrations are accompanied by friction the temperature of the object may be raised or the absorbed energy may bring about chemical changes. With constant light intensity, the abiotic action of ultra violet light increases with the vibration frequency. The effect which a slight extension of the solar spectrum might have upon the life is shown by an experiment made by Bovie, who tested the killing power of light of various wave-lengths between 3,000 and 2,500 Angstrom units (sunlight ends at about 2,950 Angstrom units. Bacteria and the spores of various fungi were used. It was found that light of wave-lengths shorter than 2,925 Angstrom units would kill by an exposure of 10 minutes, while for wave-lengths longer than 2,925 Angstrom units the organisms were not killed by an exposure of 120 minutes. A change of wave-length of only 25 Angstrom units was sufficient to cause this great change in the killing power of the light.

Ultra violet light can penetrate the blood-filled skin but a fraction of a millimeter, but if the skin is rendered anemic by pressing out the blood, bacteria can be killed by ultra violet light which has passed 4.25 millimeters of skin. This fact is of importance in connection with the question of the pathological effects of an excess of light. The energy of the light absorbed might cause a decomposition of the substances contained in the blood, and the blood stream would become loaded with protein decomposition products. Hasselbach has shown that ultra violet light of wave-length less than 3,100 Angstrom units causes a decomposition of the red blood corpuscles.

Photodynamic Effects.

There is another phase of the action of light which has great biological interest, a phase which Bovie thinks should be more extensively investigated. This is the so-called "photodynamic effect" of fluorescent substances. Vogel in 1873 showed that when certain fluorescent stains are added to the gelatin of a photographic plate, the plate becomes more sensitive to those colors which these stains absorb.

The silver salts used in sensitizing the photographic plate are normally more sensitive in the violet and ultra violet part of the spectrum than they are in the red and orange part. If, however, a fluorescent stain which absorbs, for example red light, be added to the plate, the sensitiveness of the silver salt to red light will be increased so that it may equal or even exceed the sensitiveness to violet and ultra violet light. In other words, red light acts on silver salts plus a fluorescent substance as ultra violet light does on the silver salts alone. Fluorescent stains are regularly employed in the manufacture of certain orthochromatic plates. It has been found that the stain added must form a very close union (chemical?) with the silver salts, the union must be at least such that the stain is not removed by washing. The fluorescent substance acts as a sensitizer and catalyzes the light reaction for the light-waves which it absorbs. A great many photochemical reactions have been brought about by the use of such catalyzing agents.

In 1900 a Russian, and later in the same year, Tappeiner and Rabb, found that if infusoria are placed in a 1 to 1,000,000 solution of acridin (a fluorescent substance) and the culture kept in the dark, the organisms are not injured, but if the culture is exposed to the diffused light of the laboratory, the organisms are killed.

The importance of these facts is evident. Living tissues and ferments may, by the presence of fluorescent substances, be sensitized so that they are destroyed by an exposure to visible light as though they were exposed to ultra violet light. In this connection it is interesting to note that physicists have, by improved methods of study, found that fluorescence is a much more common property of substances than was formerly believed, indeed, the search has turned so that now one looks for substances which do not fluoresce. And, moreover, fluorescence is particularly common in the organic compounds formed by living protoplasm. The two best known fluorescent substances are the characteristic coloring materials of the plant and animal kingdoms, chlorophyll and hemoglobin.

It appears as if the ability which plants have of forming carbohydrates from carbon dioxide and water is due to the photodynamic action of the fluorescent chlorophyll. We can form carbohydrates from water and carbon dioxide in the laboratory by the use of ultra violet light. In the plant in the presence of the fluorescent chlorophyll, the union is made by red and orange light.

It is interesting to note that under the conditions which, according to Arrhenius, must have existed before the carboniferous era, when the carbon of the coal and the rocks was in the atmosphere and when the earth thereby experienced a tropical climate nearly to the poles; under these conditions it has been shown that light waves shorter than red and orange could not have reached the surface of the earth. The plants, therefore, were forced to use a method whereby these rays could be utilized for photosynthesis. Hemoglobin, which is chemically so similar to chlorophyll and also fluoresces, has the complementary color of chlorophyll. It reflects the red and the orange—precisely those rays which the chlorophyll absorbs.

Hausmann found that the alcoholic extract of etiolated plants contains a fluorescent substance which has a photodynamic effect on the red blood corpuscles. Blood corpuscles were also sensitized by chlorophyll green and hematoporphyrin. He sensitized egg albumin to light by animal gall, bilirubin, urobilin and hematoporphyrin. He also sensitized red corpuscles by these substances. Later he injected hematoporphyrin into mice. Such injected mice if kept in the dark showed no signs of sickness, but if exposed to the diffused daylight of the laboratory they quickly developed reddening at the tip of the nose and tail, like sunburn, and soon died. Another investigator found that a frog's tongue sensitized with eosin and exposed for seven minutes to yellow light showed changes similar to those produced by ultra violet light.

Dryer and a number of other investigators have found that the eating of buckwheat produces a marked photosensitiveness in the skin of certain individuals, and he has succeeded in isolating a fluorescent substance from buckwheat flour.

The list of investigations given above leaves no room for doubt that physiological changes may result from photodynamic light reactions. Our bodies contain many substances which under proper conditions may act as sensitizers. For example, hemoglobin does not sensitize until it has escaped from the corpuscle. But there are many pathological conditions which are attended by hemolysis. Any increase in the photosensitiveness which may attend these conditions may have escaped our notice. Finsen's red light treatment for smallpox is interesting in this connection. Ryan, the present director of the Finsen Light Institute, claims to have had uniformly excellent results with the red light treatment for the last 22 years. Ryan emphasizes the rule which Finsen laid down in his early papers: In studying the effects of light upon organisms which have been sensitized by photodynamic substances, one must use the same care in excluding light from the controls as is used in the handling of photographic plates.

Since visible light has a much greater penetrating power than ultra violet light, the pathological conditions produced by photodynamic light reactions will probably be more deeply seated than those produced by ultra violet light. A large per cent. of "sunlight" ultra violet light is absorbed in the blood stream, in which tissue important photochemical changes take place. Visible light may have an effect on sensitized tissues as destructive as that of ultra violet light on normal tissues.

Fluorescence of Dyes.

Neuberg and *Galambos* (Biochem. Zeitsch., 1914, 61, 315; J. Chem. Soc. 1914, Abs. 106, ii, 402) have noted the action of dyes on glycerol, alanine, and tartaric acid. Dyes from the following groups were selected: Fluorescein, rhodamine, anthracene, acridine, triphenylmethane dyes, ethyl-red, nigrosine, and aesculine. Of the dyes investigated, sodium dichloroanthraecenedisulphonate, and sodium anthracene-2:7-disulphonate, were the only substances which were found capable of inducing decomposition of chemical substances in light, and they produced in this way degradation of a large number of organic substances. The theory of the action is discussed by Neuberg and Galambos, who reject von Tappeiner's idea that dyes act catalytically in light by virtue of their fluorescing properties. They suggest that the active substances can function as oxygen acceptors in light.

When a condenser spark passes between aluminum electrodes screened by a metal strip, although nothing is visible to the eye, a photograph taken with a quartz lens shows that the air around the spark is glowing with ultra violet light for a very short distance. This was shown by *Wood* (Phil. Mag. 1910, *20*, 707) not to be due to fluorescence of the air caused by the absorption of Schumann waves or to scattering of the light of the spark by air or dust. This phenomenon was further investigated by *Wood* and *Hemsalech* (Phil. Mag. 1914, *27*, 899), who used an improved form of apparatus. The fluorescence excited by the radiation from the spark was resolved by a quartz prism placed in front of a quartz fluorite achromatic lens, behind which was situated the plate on which photographs were taken. In this way, the spectra obtained in an atmosphere of oxygen, nitrogen, air, carbon dioxide, hydrogen, and coal gas have been examined. The most interesting results are those obtained by comparing the fluorescence of gases in a stationary and in a moving condition. Some gases show a much more brilliant fluorescence when moving across the jet of rays from the spark whilst the others show no luminosity in these circumstances, although they respond vigorously to the excitation when quite stagnant. *Steubing* (Physikal. Zeitsch. 1914, 15, 742-744) criticizes the view that ultra-Schumann waves are emitted by spark discharge and maintains that no satisfactory proof has yet been given: (1) that the fluorescence spectrum is different from that of the exciting spark discharge; (2) that shattering of the light emitted by the spark discharge is eliminated by the experimental arrangement adopted by Wood and Hemsalech; and (3) that ultra-Schumann waves are actually emitted by the spark.

Kennard, (Chem. Abs. 1918, 650; Cornell Univ. Phys. Rev. 1918, 38) considers fluorescence a reversible process. Assuming that fluorescence and thermal radiation are thermodynamically independent and that the energy of fluorescence is derived from that of the exciting light, it is shown that in the case of an isolated unitary band the relative intensity in the fluorescence spectrum is proportioned directly to the product of the exciting power and the intensity in the black body spectrum for the temperature of the substance, all being taken for the same wave length. Experimental data seems to confirm this relationship.

Effect of Specific Rays on Animal Tissues.

Moycho (Compt. rend. 1913, *156*, 577) exposed the external surface of the ear of a rabbit to short irradiation for (thirty seconds) without producing any visible effect. If this is prolonged for one to twelve minutes, however, a series of phenomena appears. After two to five hours, local vaso-dilatation is noticeable, the portion which was exposed to the rays becoming red, this being accompanied by rise in temperature and tumefaction. The maximum effect is reached in twenty four hours, then diminishes and finally at the end of seven to twelve days the redness and high temperature completely disappear, and a persistent brown pigment appears. The irradiation appears to have a stimulating effect on the hair growth. The most active rays are those having λ = 3100 — 2900, and the cells acted on are situated at a depth of 1/10th to 1/6th mm. below the surface. *Henri* and *Moycho* (Compt. rend. 1914, *158*, 1509; J. Chem. Soc. 1914, Abs., *106*, i, 902) studied the effect of monochromatic ultra violet rays, from λ2300 to 3300, on the ear of a rabbit, the time of exposure for production of a redness after twelve to twenty-four hours, being measured. The extreme ultra violet rays 2300-2500 have no sensible action on the tissues of the ear. The most active region in the ultra violet is at λ2800, the energy necessary to produce an irritation of the tissues being 0.057×10^7 ergs. For λ3300, no visible effects could be obtained. At the sea level the solar spectrum stops at about 3000, and the amount of energy which reaches the earth from this region of the spectrum is such as would produce sunstroke in one hundred minutes. At levels higher than this, the time of exposure would get less as the height increased. If, instead of continuous radiation, the ear is subjected to intermittent treatment, the visible effect is produced when the sum of the short radiations is equal to the continuous radiation, providing that the intervals between the application of the light do not exceed forty-eight hours. (Compt. rend. 1913, *156*, 1268.)

Burge and *Neill* (Amer. J. Physiol., 1915, 88, 401; J. Chem. Soc., 1915, Abs. 108, i, 1042) observe that fluorescent bacteria are relatively highly resistant to the destructive action of ultra violet rays. Like the lens protein, they are able to protect themselves from coagulative effect of these rays by being able to convert rays of short wave-length into longer waves, and thus dispose of the energy of the absorbed short waves. This power is absent in non-fluorescent bacteria.

Thiele and *Wolf*, (Arch. Hyd., 60, 29; Chem. Abs. 1907, 1029) in an investigation of the destruction of bacteria by light, state that ultra violet waves kill bacteria rapidly at 14°—20° and that the destructive action is hastened at higher temperatures. With visible waves the effects are less intensive. The bactericidal action is not due to the hydrogen peroxide which is formed by the light.

Agulhon (Compt. rend. 1911, 153, 979) concludes that enzymes are divisible into three classes according to their sensitiveness to light, Sucrase, tyrosinase, and laccase are destroyed by visible rays only in the presence of oxygen; in a vacuum they are destroyed only by ultra violet light. Probably in the absence of molecular oxygen, hydrogen peroxide is the effective agent of decomposition. Emulsion and catalase are destroyed by light of all wave-lengths, even in a vacuum, but more rapidly when oxygen is present. Rennet is an example of a third type, the activity of which is impaired by visible rays, but is rapidly destroyed by ultra violet radiation in a vacuum.

Amylase and Lipase.

Two methods have been employed by *Chauchard* (Comp. rend., 1913, *156*, 1858) in the study of the effect of variation in the wave-length of the ultra violet light employed on the rate of destruction of amylase. In the first of these, the source of light is the spark passing between cadmium electrodes. The light is filtered by suitable screens and allowed to traverse the solution of amylase, when it is found that the rays $\lambda=2469$, 2300 and 2195 are more active than those of greater wave length. In the second series the light from a spark passing between magnesium, cadmium, or zinc poles is resolved by two quartz prisms, and the individual rays are allowed to act on the amylase solution. The amount of decomposition is found to increase as the wave-length of the light employed decreases. By a comparison of these results with the absorption of the different rays by the amylase solution, the conclusions are reached that: (i) the photochemical action of ultra violet rays on a solution of amylase is proportional to the absorption of these rays by the solution, and (ii) an amount of radiant energy sufficient to raise the temperature of the solution through only ¼ degree is capable of bringing about the destruction of 40 per cent. of the amylase. Chauchard (Compt. rend., 1914, *158*, 1575) further reports that the amylase of pancreatic juice is attacked appreciably only by rays where $\lambda = 2800$. The action increases very rapidly as the wave-length diminishes. The lipase is destroyed by the rays, where $\lambda = 3300$, these being without action on amylase. No relationship exists between the absorption of ultra violet rays by pancreatic juice and the action on lipase or amylase, owing to the presence in the juice of different substances which absorb the ultra violet rays unequally.

Acids and Esters of Plants.

Attention is called by *Spoehr* (Biochem. Zeitsch. 1913, *57*, 95; J. Chem. Soc., 1914, Abs., *106*, ii. 120) to the fact that plants have a more acid reaction in the morning, and that the acidity, for the most part, disappears on exposure to light. It is shown that certain plant acids, especially diabasic acids, readily undergo decomposition (but only in the presence of air) when exposed to ultra violet light in quartz vessels. Malic and tartaric acids lose two molecules of carbon dioxide under these conditions, and the alcohols thus formed are oxidized further to acetaldehyde and acetic acid. The latter acid also undergoes decomposition, yielding formaldehyde and formic acid. The last named acid yields carbon dioxide as final oxidation product. Acetaldehyde, under these conditions of light-oxidation, can give rise to oxalic acid. Under the conditions of light-oxidation, therefore, the ordinary plant acids can give rise to volatile oxidation products. The discovery of formaldehyde as a product of light oxidation of acids throws some doubt on the significance of Baeyer's hypothesis, according to which the aldehyde is a direct photochemical product of carbon dioxide, as it can be produced from plant acids. Stoermer and Ladewig (Ber. 1914, *47*, 1804) suggest that ester formation in plants is due to the ultra violet rays of sunlight.

Test Paper Sensitive Only to Ultra Violet.

Schall (Chem. Ztg., *34*, *267*) notes that paper prepared with p-phenylenediamine nitrate (2/3 normal) is sensitive only to waves shorter than 313 *μμ*. As the solar spectrum ends at about 295, the paper is suitable for determining the variations (e.g., with altitude) of the solar radiation of short wave length and has been used for this purpose.

Heraeus Lamp for Chemical Tests.

A mercury vapor lamp of the Heraeus type used by *Foster* (J. Chem. Soc. Trans., 1906, *89*, 913) is shown in *Figure* 1. The essential part is a small bore tube A, of quartz, bent into U-shape with the arms close together. The uper ends are bent over and end in bulbs, which are filled with pure mercury up to the level shown. Platinum contact wires pass down two other tubes which are sealed into the bulbs at the back. The bulbs, inlet tubes for the wires, and part of the U-tube are all inclosed in a brass casing C, which has a glass front not shown in the sketch. The projecting part of the U-tube is inclosed in a thin-walled quartz tube, B, which is cemented into the brass casing. Close behind the U-tube a nickel tube enters, through which water flows. The water fills the whole of B and C and is carried away by another tube at the top, so that a water-jacket surrounds the lamp and keeps it quite cool. The lamp is lighted by inverting it slowly so that the two threads of mercury in the U-tube meet at the bend. On turning the lamp in the reverse direction, the arc is struck, and fills the whole of the U-tube up to the mercury bulbs. A starting resistance is necessary owing to the momentary short circuit which occurs when the mercury threads meet. The lamp requires

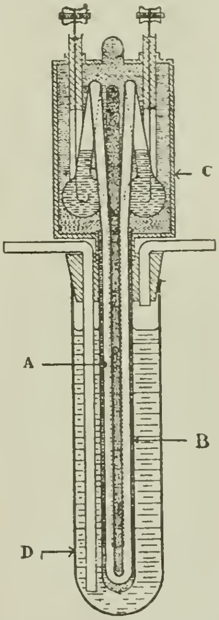


Figure 1.

230-240 volts, and uses 5-6 amperes. The solutions undergoing exposure were contained in a large tube. D, similar to a large test-tube, which was fitted to B by means of an india rubber stopper. Two glass tubes passing through this allowed gases to be bubbled through the solutions.

The lamp gives a very large amount of ultra violet radiation; when burning in air, a very powerful odor of ozone is perceived, and the radiation can be distinctly felt on the hand. If a N/1000 solution of potassium permanganate containing 9 per cent. of sulphuric acid is exposed to this light in the tube D, it is completely decolorized in ten minutes with evolution of oxygen. A solution of potassium iodide (0.09N) and starch becomes absolutely black in two minutes.

Uviol Lamp With Light Filter.

An apparatus used by *Luther* and *Forbes* (J. Am. Chem. Soc., 1909, 770) employing a light filter is shown in *Figure 2*. Three cylindrical glass tubes A, B, and C, were set in a ring-shaped pan of sheet tin, P; their lower edges were made concentric by suitable pieces of brass soldered to the floor of the pan, their upper edges by bits of wood. The average distance between A and B was 0.71 cm., between B and C 1.56 cm. Two small glass tubes, not shown in the cut, were passed through holes in the pan, barely projecting into the spaces between A and B, and B and C, respectively; through these tubes a solution in either compartment could be drawn off at pleasure. The inner edge of the pan could be kept cool by a current of water flowing through D, a coil of small lead tubing. Next, the pan was filled with melted cement, which, on cooling, made the apparatus tight. The source of light was a uviol mercury vapor lamp U clamped in the axis of the apparatus. The mixture to be exposed to light was placed in the outer vessel or compartment. The latter was cooled by a glass tube wound in a double spiral, through which flowed brine at a temperature below zero from a large reservoir placed above the apparatus and filled with water, ice, and salt; the brine was forced back into the reservoir by a small mechanical pump driven by an electric motor. The spiral was made to act as a stirrer at the same time by hanging it to an eccentric E on a wheel high above the apparatus and rotated by the motor. To prevent the moisture which collected on the cold shafts of the spiral from flowing down and diluting the solution, a small cup of lead foil was cemented about each shaft; these cups never touched the reaction mixture. The light filter solution was placed in the inner vessel or compartment. The latter was cooled and stirred by a different device: a Liebig condenser with cold water jacket was suspended above the apparatus; a filter pump was connected through a capillary and a large bottle to the upper end of the condenser tube; from the lower end a finer tube ran down below the surface of the filter solution. When the pump was started, the liquid was drawn up into the condenser and cooled, but as soon as the liquid fell below the end of the tube, air rushed up through the condenser and restored normal pressure throughout the system; thereupon the liquid ran back into the light filter vessel before a partial vacuum could again be established through the capillary. This operation repeated itself at regular intervals.

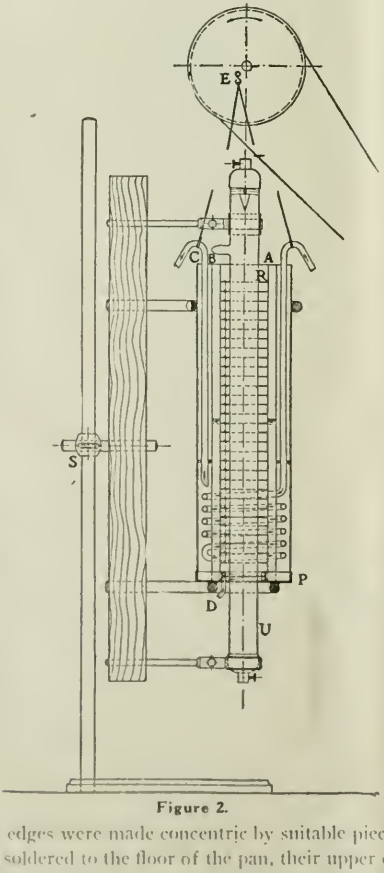


Figure 2.

The Distribution of Energy in the Radiation from the Uviol-Glass Lamp.

Allmand (Trans. Chem. Soc. 1915, 107, 682; J. Chem. Soc., 1915, Abs., 108, ii, 400) has determined the distribution of energy in the radiation emitted by a Schott mercury Uviol-glass lamp by direct measurement of the intensity of the different bands by means of a thermopile. The light was resolved by means of a Hilger monochromatic illuminator, and the thermopile current measured with the aid of a Paschen galvanometer. The intensities of the bands, referred to the blue band = 1, are compared with the corresponding values (in brackets) obtained by Winther, who used a fluorometer for the energy measurements. The numbers obtained are: λ 571 $\mu\mu$, 0.27, (—); λ 541, 0.73, (—); λ 436, 1.00, (1.00); λ 405, 0.56, (0.29); λ 362, 0.42, (0.25); λ 313, 0.17, (0.045). On comparison of the results with those obtained for the quartz lamp by Ladenburg (Physikal. Zeitsch., 1904, 5, 525), it is found that the relative intensities of the blue (λ 436) and violet (λ 405) bands are approximately the same for the two lamps, but that the intensities of the ultra violet and of the green and yellow bands relative to the blue are much smaller for the Uviol than for the quartz lamp.

By applying the results to the data obtained by Luther and Forbes (J. Chem. Soc., 1909, Abs., 96, ii, 632) in the investigation of the photochemical oxidation of quinine by chromic acid, it is found that the ratio of the intensities of the bands λ 406 and λ 362 is 1.00:0.75, which is in good agreement with the corresponding ratio of the velocity-coefficients, 1.00:0.82. This would seem to show that the reaction velocity is proportional to the absorbed energy, and independent of the frequency of the light.

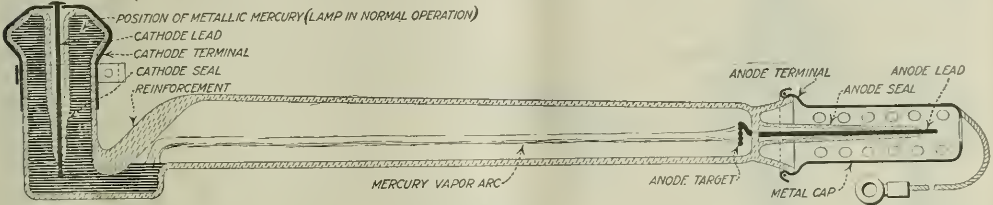


Figure 3.

Aluminum Arc.

In some investigations conducted by *Ross* (J. Am. Chem. Soc., 1906, 786) on the chemical action of ultra violet light, the source of light was obtained by causing an oscillatory spark to pass between aluminium terminals joined in the secondary circuit of a large induction coil used as a transformer. In the secondary circuit was also joined in parallel a large Leyden jar. Through the primary circuit was passed an alternating current of 110 volts having a strength of 3.4 amperes. To obtain a constant source of light proved a matter of considerable difficulty. However by arranging an apparatus as thus described and having in the primary circuit an ammeter and resistance boxes, the resistance could be changed at will and the strength of the current thus kept constant. When a uniform current was in this way maintained, the amount of energy given out by the spark during intervals of ten minutes was practically constant. This was shown to be the case by the fact that the same amount of iodine was set free from equal volumes of potassium iodide solution, when exposed to the light under exactly the same conditions for equal intervals of time. After every observation the aluminium terminals were sharpened, and then placed the same distance apart so that every exposure might be begun under the same conditions. The terminals used were large—3 mm. by 8 mm. cross-section—and were allowed to rest for the greater part of their length on iron plates placed 7 cm. apart. In this way the heat generated by the spark was rapidly conducted away. By placing the proper amount of ice in small dishes resting on the terminals, the temperature of a solution of 3 cc., placed in a cell directly underneath the spark, could be kept within a range of 1° during an exposure of ten minutes. Aluminum terminals were used on acount of the strong ultra violet rays given out by a spark passing between them. The rate of decomposition produced by the light in the case of the iodides, when terminals of aluminum were used, was found to be at least twice as great as that resulting when terminals of any of the other common metals were used. Cadmium could not be used on account of its softness. An accurate comparison of the decompositions produced, when electrodes of different metals were used, was not made, since, on account of their difference in hardness, the experiments could not be carried out under comparable conditions.

Ultra Violet Tungsten Arc.

According to *Luckiesh* (J. Frank. Inst., 1918, 552) there is not available a light source emitting a continuous spectrum between 200 and 400 $\mu\mu$. The quartz mercury arc emits many lines in this region, but the spectrum does not approximate continuity. Some arcs (particularly flame arcs) and electric sparks provide ultra violet spectra which find many uses, but these are not usually steady sources. The ultra violet spectrum of a tungsten arc is very rich in lines in this region, and inasmuch as a tungsten arc can be made to operate quite steadily in certain gases, its spectrum was studied with the aim of determining the adaptability of such an arc to various problems. A glass bulb was provided with a quartz window opposite the tungsten electrodes. Commercial argon, containing about 20 per cent. of nitrogen, was admitted to the evacuated bulb at a pressure of 20 cm. of mercury. Spectrograms were made for currents varying from 0.3 ampere to 5.0 ampere. For this particular arc the ultra violet energy between 200 and 300 $\mu\mu$ is relatively weak for the lowest currents at which the arc operates. Spectrograms are shown for currents up to one ampere, the exposure being constant for the entire group. The spectrum between 300 and 400 $\mu\mu$ may be considered approximately continuous for some purposes, although shorter exposures show that it is somewhat fluted in character. The arc voltage varied from 28 to 16 volts as the current increased from 0.3 to 5.0 amperes respectively, thus consuming from 5 to 80 watts. This arc was quite steady and is adaptable to many physical and chemical problems. It may be made much more powerful to suit requirements.

Hot Anode Lamp.

A quartz mercury vapor lamp known as the "hot anode" type is manufactured by the R. U. V. Company, New York City, N. Y. (Met. & Chem. Eng. 1918, 43) which is novel, in that there is no mercury chamber at the anode end. This is shown in *Figure* 3. In place of mercury, a tungsten target composed of a spiral formed of tungsten wire is used. The anode end is protected from mechanical injury by means of a metal cap which also serves to lead the current to the anode. The cathode end is reinforced with thick quartz to absorb the shock of the mercury vapor and is set at an angle which is claimed to reflect back into the luminous portion of the tube some ultra violet rays which would otherwise escape. The cathode end is also protected by a metal cap through which the current is led to the mercury. The tungsten wire which serves to lead the current into the lamp is sealed into the quartz tube by a graduated mixture of quartz and glass so that at the end there is practically pure glass, while the portion next to the quartz tube is practically pure quartz. It is claimed that this combination of glass and quartz provides a proper co-efficient of expansion so that the loss of vacuum is prevented. Having only one mercury electrode, this lamp is capable of being operated either in a vertical or horizontal position, which in certain cases is of advantage.

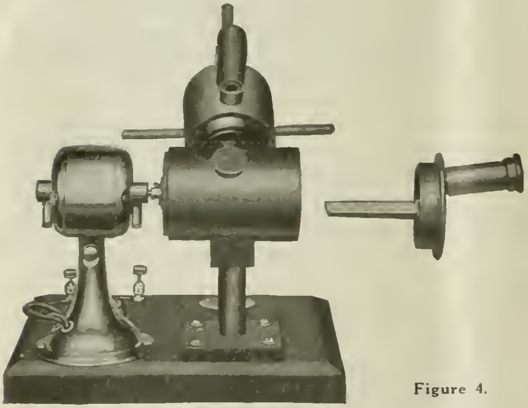


Figure 4.

The Phosphoroscope.

A form of phosphoroscope is described by Andrews (General Electric Review, 1917, 259) which consists of a source of ultra violet rays, a chamber containing a tray upon which the substance under examination is placed, a light proof chamber for holding the tray and a small motor which operates a revolving shutter. (See *Figure* 4). Eye pieces are placed in the light-proof chamber for observing the effect of the light upon the substance under examination. As the boundary between fluorescence and phosphorescence is not sharply defined it is very difficult to determine whether a given substance continues to glow after being exposed to invisible light rays as a small fraction of a second may be the life of the phosphorescence, although in other cases the material may continue to glow for several hours after being exposed. In operating the apparatus the substance to be examined is placed on the tray and the motor started, thereby revolving the shutter at a speed which cuts off the light at from 3000 to 4000 times per minute. In case the substance shows continuous illumination it is phosphorescent, while if the substance appears to flicker it is fluorescent. A general idea of the range of time which a given substance continues to phosphorize may be obtained by changing the speed of the motor thus lengthening or shortening the period of illumination and the period of darkness.

An arrangement of apparatus is described by *Hauer* and *Kowalski* (Physikal. Zeitsch., 1914, 15, 322; J. Chem. Soc. 1914, Abs. 106, ii, 320) which has been found suitable for the examination of the phenomena of luminescence. It consists of a monochromatic ultra violet illuminator and a spectrophotometer adapted to the measurement of the intensity of comparatively faint luminescent radiation. Various observations made with this apparatus are described. It is shown that the momentary and progressive phosphorescence of phenanthrene can be readily distinguished, and that the progressive bands are only excited by light which falls within the region of selective absorption of the phenanthrene. From experiments with lithium platinocyanide it is found that the intensity of the fluorescent light reaches a maximum when the wave-length of the exciting light is $\lambda = 390\ \mu\mu$. The data obtained with rubidium platinocyanide seems to show the existence of a maximum fluorescence, the position of which depends on the wave-length of the excitation. From observations on the phosphorescence of calcium sulphide containing samarium as "active impurity" at different temperatures, it has been found that the rate of decay of the phosphorescence increases with the temperature, but this temperature effect varies from one band to another, and thus gives rise to change in color of the phosphorescent light during the process of decay. For different bands the phosphorescent attains a maximum at about the same temperature, but since the influence of temperature on the intensity varies from one band to another, change of temperature produces a change in the color of the phosphorescent light.

Separating Visible from Invisible Light.

Andrews (General Electric Review, 1917, 817) furnishes details of an apparatus for separating visible from invisible light, the theory of the apparatus being that the visible light is less refracted by a lens than is ultra violet light. *Figure* 5 diagrammatically shows the design of the apparatus. A is a source of visible light, also producing ultra violet rays, such as may be produced by a high tension disruptive spark between iron terminals. B is a quartz lens. D is a thin sheet of metal pierced with a pin-hole at C, the diaphragm being so placed that the pin-hole is in the exact mean focus of the ultra violet rays. E indicates the mean focus of the visible rays. F is a small metal disk and G is a screen. A front view of the screen is shown at H. The operation of this instrument is based on the fact that the mean focus of visible light is located at a measurable distance beyond the mean focus of invisible ultra violet light owing to the greater refrangibility of the latter over that of the former. If, therefore, the diaphragm D is carefully adjusted so as to bring the pin-hole C into the exact mean focus of ultra violet light, the rays of the latter will pass through the pinhole and spread out again on the other side of the diaphragm. The mean focus of visible light being some distance beyond the pin-hole, its rays will be largely intercepted by the diaphragm, and through the pin-hole only a few of the nearly parallel rays of visible light will pass. In operation, if the screen H is made of non-fluorescent material, there will appear on it only the small illuminated spot K, but if it is coated with a fluorescent substance, such as powdered willemite, this small luminous spot will be surrounded by a disk of bright green light produced by the fluorescence of the willemite excited by the circular field of invisible ultra violet rays. Should it be found desirable to cut out the spot of visible light, the small metal disk F can be set up in such a position as to cast its shadow over the spot K and so transform it from a bright spot to a dark one, leaving the disk of green fluorescent light otherwise unchanged.

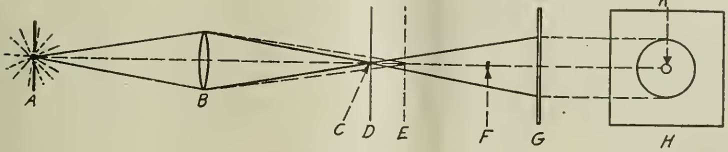


Figure 5.

This apparatus is valuable for the determination of the exact fluorescent colors of various compounds. When such compounds are exposed to the direct rays of an open iron spark, their true fluorescent color is masked to a greater or lesser degree by the visible light component of the spark, this being especially the case with compounds that show only a weak fluorescence. When a compound is placed within the invisible field of the ultra violet rays of this separator, it shows its true fluorescent color and the fluorescence, if pronounced, manifests itself on a visually dark field, as an illumination of a surprising character.

An apparatus for subjecting air to light rays and producing ozone is described by Markel (Chem. Abs., 1918, 644) Can. Pat. 182,371, Feb. 19, 1918). Nonconducting plates having the corresponding faces covered with powdered iron are so arranged in a receptacle that the air can pass around the edges. The coatings are claimed to prevent arcing except through the nonconducting plates.

Electric Accumulator.

Winther (Zeitsch. Elektrochem. 1912, *18*, 138; J. Chem. Soc., 1912, Abs., *102*, ii, 318) suggests a novel form of electric battery based on the reaction between ferrous and mercuric chlorides. When an aqueous solution of ferrous and mercuric chloride is exposed to ultra violet light, the system is partly transformed into ferric chloride and calomel. The reverse reaction proceeds spontaneously and completely; it is extremely slow at the ordinary temperature, so that the products can remain in contact without appreciable change, but when arranged to give a current, it goes at a much greater rate, which depends on the temperature. For purposes of investigation the cell was constructed as follows: In a glass funnel, closed at the lower end, a perforated platinum plate was fixed; the plate was soldered to a platinum wire which passed out through a hole in the funnel. On the plate a layer of platinized asbestos was placed and then the solution which was exposed to the light from a quartz-mercury vapor lamp. After the illumination the differences of potential were measured, a platinum electrode being placed for this purpose in the upper liquid. The E.M.F. in some cases was as much as 0.1 volt, and currents of 1 milliamp. were obtained. The results were complicated by the oxidation of the ferrous salt by the oxygen of the air; the effect of this process on the equilibrium is discussed in detail. Another uncertainty arose from the fact that owing to insufficient stirring the concentration of ferric chloride was not the same in the upper and lower layers. The apparatus was also exposed to sunlight and gave E.M.F.'s of 20-30 millivolts, but owing to the slowness of the action the results were greatly complicated by direct oxidation.

Light and Electric Energy.

Reactions which can be induced photochemically and electrochemically have been compared by *Smiths* and *Aten* (Z. Elektrochem. *16*, 264; Chem. Abs. 1910, 1842). Ultra violet rays (from a mercury lamp) transmitted through quartz and the discharge from an ozonizer were used to produce the photochemical and electrochemical equilibria respectively. It seems probable that the action of light and of the electrical discharge is the same, namely, a displacement of the equilibrium in the endothermal direction. An attempt to produce the decomposition, $I_2 = 2I$ (as judged by the change in pressure) was unsuccessful, as was also the attempt to obtain compounds from chlorine and oxygen and from nitrogen and iodine.

Thompson (Proc. Camb. Phil. Soc. 14, 417, 1907) exposed various gases to the action of ultra violet light and observed the effect of this exposed gas on an electroscope. When exposed to ultra violet light, air increased the natural leak eight times, carbon dioxide sixteen times and ammonia over one hundred and fifty times. The light rays which produce this ionization are absorbed by a few millimeters of air.

Improvements in the Manufacture of Synthetic Phenol

According to the well known process, phenol is prepared from benzene, by successively sulfonating the benzene in presence of an excess of sulfuric acid, and decomposing the sulfonate by means of sodium hydroxide, in excess. At the completion of this stage of the reaction, the phenol exists as sodium phenolate and is liberated by neutralizing the phenolate by any appropriate acid.

The decomposition of the sodium phenolate was formerly accomplished by mineral acids, such as hydrochloric or sulfuric acid, and later by carbon dioxide. The use of carbon dioxide has the advantage that the sodium is recovered in the form of carbonate, and can either be used as such or readily causticized.

In the decomposition of the phenolate by carbon dioxide, it has been found that in case the pure (undiluted) gas is used, the reaction is rather sluggish, although it is eventually completed with good yields of phenol. The undiluted gas is, howeve, relatively expensive. If, on the other hand, lime-kiln gases are employed in lieu of pure carbon dioxide, the reaction proceeds much more slowly, and there are material losses of phenol, which is swept away by the nitrogen with which the lime-kiln gas is diluted.

Henry Howard of Boston (Amer. Pat. 1,245,343, of No. 6, 1917) has devised a method to overcome these difficulties.

According to his invention, the sodium phenolate prepared as usual by the caustic fusion of the sulfonic body, is decomposed by sodium bicarbonate, preferably employed in the proportions required to transform all of the sodium present into normal sodium carbonate.

Under these conditions the reaction is very rapid and even practically instantaneous. The reaction proceeds at normal and higher temperature, and is exothermic. 60° C. is a satisfactory operating temperature, although either higher or lower temperatures may be used. A concentration of the phenolate solution in the neighborhood of 23° Baumé is satisfactory in practice. To avoid unnecessary dilution the bicarbonate may be added in the solid form, although this is not essential. Most of the phenol rises to the surface of the liquid and may be separated by decantation, the remainder being recovered from the carbonate solution in any appropriate way, as for instance by distillation, or by blowing steam through the liquid.

About one-half or somewhat less of the sodium carbonate solution produced as above is treated in any suitable apparatus with lime-kiln gas, and is thereby reconverted into sodium bicarbonate, which is used for the treatment of another batch of sodium phenolate. The remainder of the sodium carbonate solution is causticized by lime, and may be concentrated for re-use in the preparation of the phenolate.

The method is, naturally, applicable to the preparation of phenols in general.

Another process for accomplishing the same purpose has been perfected by Herbert S. Kimball, of Newton, Mass. (Amer. Pat. 1,245,353, of Nov. 6, 1917), and is assigned to the Merrimac Chemical Company.

His invention is carried out as follows: Benzene is first sulfonated and the resulting sulfonic acid, containing an excess of sulfuric acid, is wholly or partly neutralized by calcium sulfite, utilizing for this purpose the calcium sulfite produced at a later stage of the cyclical process, as explained below. The neutralization is effected in closed tanks, and the evolved sulfur dioxid, or such portion thereof as may be required, is employed to decompose the sodium phenolate as described below. In case the quantity of calcium sulfite available is insufficient for complete neutralization of the sulfonic acid, it is supplemented by lime or limestone.

The calcium benzene sulfonate, obtained as above, is treated with the molecular equivalent of sodium sulfite, and is thereby transformed into sodium benzene sulfonate. The sodium sulfite may be introduced either in solution or in solid form. The calcium sulfite, which separates out, is applied toward the neutralization of the sulfonic acid produced in the first step of the process.

The sodium benzene sulfonate is now subjected to a caustic fusion to produce sodium phenolate, which in turn is decomposed by sulfur dioxide (undiluted) arising from the neutralization step of the process. The phenol is decanted, and the remaining liquor, containing sodium sulfite or bisulfite or a mixture of these, is utilized in part for the conversion of the calcium benzene sulfonate into the corresponding sodium salt as above described, and is in part causticized by lime, yielding a dilute caustic soda solution, and calcium sulfite, the latter available for neutralizing the benzene sulfonic acid. If desired the caustic soda solution may be concentrated and returned to the cycle.

A complete cycle embodying the invention is shown on the accompanying diagram.

The use of sulfur dioxide for decomposing sodium phenolate, forming one phase of this cycle, is the invention of Mr. H. Howard, who has applied for a patent on the same.

Exports of Indigo from Madras

U. S. Consul Lucien Memminger writes from Madras, India, to Commerce Reports, that exports of indigo from the Madras Presidency to foreign countries during the seven months from April 1 to October 31, 1917, according to figures furnished by the Custom House, were: To United States, 5,488 pounds, valued at $8,435; United Kingdom, 65,408 pounds, value $77,326; Straits Settlements, 21,056 pounds, value $19,093; Australia, 1,120 pounds, value $1,110; China, 8,736 pounds, value $11,320; Japan, 23,520 pounds, value $25,273; Ceylon, 28 pounds, value $9; total, 125,356 pounds, valued at $142,566.

INORGANIC CHEMICAL SYNONYMS

A Novel Work of Reference for Student and Chemist

By

ELTON R. DARLING*

Although Intended Primarily for the Student, It Is Believed that the Following Compilation of the Various Terms Employed to Designate Inorganic Chemicals Used in the Industries Will Prove a Convenience to the Experienced Chemist. The Writer Claims No Originality for the Synonyms, but Only the Bibliographical Research of the Material at Hand.

Part V Will Appear in the Next Issue.

PART IV

Lead, 207.1 (Plumbum).

Lead melts at 327° C. and boils at 1525° C. It has a valency of two and four.

This metal was known to the ancients. It was supposed to have been one of the seven metals known to the ancients and to have been connected with the seven heavenly bodies. Thus lead was apportioned to Saturn.

- Lead Acetate, 379.20.
  - *Plumbi Acetas*
  - *Plumbic Acetate*
  - *Sugar of Lead*
  - *Goulard Powder*
- Lead Carbonate, 267.10
  - *Plumbi Carbonas*
  - *Plumbic Carbonate*
  - *Flake Lead*
  - *White Lead*
  - *Ceruse*
  - *Lead Spar*
  - *Cerussite (native)*
- Lead Chromate, 323.10
  - *Plumbi Chromas*
  - *Plumbic Chromate*
  - *Chrome Yellow*
  - *Paris Yellow*
  - *Leipzic Yellow*
  - *Crocosite (native)*
- Lead Chloride, 277.02
  - *Plumbi Chloridum*
  - *Plumbic Chloride*
  - *Muriate of Lead*
  - *Horn Lead (native)*
- Lead Oxide, 223.10
  - *Plumbi Oxidum*
  - *Plumbic Oxide*
  - *Lead Monoxide*
  - *Lead Protoxide*
  - *Massicot*
  - *Brown Lead Oxide*
  - *Litharge (native)*
- Lead Dioxide, 239.10
  - *Plumbi Dioxidum*
  - *Plumbic Peroxide*
  - *Binoxide of Lead*
  - *Lead Peroxide*
  - *Black Lead*
  - *Puce*
- Lead Sulfate, 303.17
  - *Plumbi Sulfas*
  - *Plumbic Sulfate*
  - *Vitriolate of Lead*
  - *Anglisite (native)*

Magnesium, 24.32.

This metal has a specific gravity of 1.74, melts at 650° C. and boils at 1120° C. It has a valence of two.

Although magnesium was obtained as a metal in 1808, our knowledge of its history goes back to 1695. At that time a London physician published an account of a new salt found in the springs at Epsom. Shortly after this publication the medical value of the salt became known, being termed epsom salts. By 1700 several springs in England were found to contain it. Soon another medical salt, Magnesia Alba, was discovered by a Roman. Several methods were soon put forward for its preparation. In 1755 Black made an attempt to study the composition of these salts. Bergman made a more complete study in the same year, but it was Davy who, in 1808, proved that this compound was the oxide of a new metal and called it "magnium," which name soon gave place to "magnesium."

- Magnesium Carbonate, 485.70
  - *Magnesii Carbonas*
  - *Basic Carbonate of Magnesium*
  - *Magnesium Alba*
- Magnesium Chloride, 203.34
  - *Magnesii Chloridum*
  - *Muriate of Magnesium*
- Magnesium Oxide, 40.32
  - *Magnesii Oxidum*
  - *Magnesia*
  - *Calcined Magnesia*
  - *Magnesia Ponderosa*
  - *Light Magnesia Calcined*
  - *Light Magnesium Oxide*
  - *Light Magnesia*
  - *Heavy Magnesia*
  - *Heavy Magnesium Oxide*
  - *Periclasite (native)*
- Magnesium Sulfate, 246.50
  - *Magnesii Sulfas*
  - *Sal Catharticum Amar*

---

*All rights of publication in book form reserved by the author. Research Textile Chemist, 251 Clifton Place, Brooklyn, N. Y.

- *Magnesia Vitriolata*
- *Epsom Salts*
- *Salts*
- *Bitter Salt*
- *Hair Bitter*
- *Kieserite (native)*

Manganese, 54.93.

It has a specific gravity of 7.42 and its melting point is 1225° C. It boils at 1900° C. and its valency is two, three and four.

The black oxide of Manganese has been known from the earliest times and was associated with magnetic iron ore. In fact, many of the alchemists believed it to be an ore of iron. Much mention was given to it in literature on glass making and long Latin manuscripts are found setting forth its uses.

In 1740 the first study of the oxide was made. At that time Pott proved that the product was free from iron. The year 1774 saw the renowned investigation of Scheele, who made such an exhaustive study of mineral manganese and its action towards oxygen. Using Scheele's experiments as a basis Bergman came to the conclusion that it was the calx of a new metal. Gahn was, however, the first to isolate this metal.

- Manganese Chloride, 197.1
  - *Mangani Chloridum*
  - *Muriate of Manganese*
  - *Protochloride of Manganese*
- Manganese Dioxide, 86.93
  - *Mangani Dioxidum*
  - *Mangani Oxidum Nigrum*
  - *Manganesii Peroxidum*
  - *Manganic Dioxide*
  - *Binoxide of Manganese*
  - *Black Oxide of Manganese*
  - *Peroxide of Manganese*
  - *Psilomelane*
  - *Pyrolusite (nativê)*
- Manganese Sulfate, 223.06
  - *Mangani Sulfas*
  - *Manganese Vitriolate*

Mercury, 200.6 (Hydrargyrum).

It has a specific gravity of 13.6. The melting point is 38.85° below zero; its boiling point is 357.33° C. The atomicity is two in the mercuric compounds and pseudo-monatomic in the mercurous.

Although mercury is one of the oldest of metals, no mention of it is to be found in old Greek writings. Theophrastus called it "liquid silver" and Dioscorides called it "silver water"; both gave a method for preparing it from cinnabar. Pliny was the first to give it the name of Hydrargyrum, and used the name only for the pure metal

The first mention of the properties of mercury was made in 1610 by Isidorus.

The first dispute as to which class mercury belonged in was raised by Agricola and Libavius. The former classed it with the metals and the latter with the semi-metals. It was not until 1759 when Braune, of St. Petersburg, succeeded in freezing it, that the question was settled.

- Ammonium Mercuric Chloride, 253.09
  - *Hydrargyri Ammoniatum*
  - *Hydrargyri Ammonio-Chloride*
  - *Hydrargyri Praecipitatum Album*
  - *Mercuric Ammonium Chloride*
  - *Mercurius Precipitatus Albus*
  - *Chloride of Mercuric Ammonium*
  - *Mercuro Ammonium Chloride*
  - *Calx Hydrargyri Alba*
  - *Ammonio-Chloride of Mercury*
  - *Amido Chloride of Mercury*
  - *Ammoniated Mercury*
  - *Infusible White Precipitate*
  - *White Precipitate*
- Ammonium Mercurous Chloride, 453.69
  - *Nigri Precipitatus*
  - *Black Precipitate*
  - *Black Mercury*
  - *Haheman's Mercury*
- Mercury Chloride, 271.52
  - *Hydrargyri Corrosivum Sublimatas*
  - *Hydrargyri Muriaticum Corrosivum*
  - *Hydrargyri Chloridum Corrosivum*
  - *Hydrargyri Perchloridum*
  - *Hydrargyri Permurias*
  - *Hydrargyri Supermurias*
  - *Bichloride of Mercury*
  - *Perchloride of Mercury*
  - *Corrosive Chloride of Mercury*
  - *Corrosive Sublimate*
  - *Dimuriate of Mercury*
- Mercurous Chloride, 236.06
  - *Hydrargyri Chloridum*
  - *Hydrargyri Chloridum Mite*
  - *Hydrargyri Murias*
  - *Hydrargyri Submurias*
  - *Mercurius Dulcis Precipitatum*
  - *Mercurius Dulcis Sublimatis*
  - *Calomelas*
  - *Calomel*
  - *Panacea of Mercury*
  - *Mild Mercurous Chloride*
  - *Sub-chloride of Mercury*
  - *Protochloride of Mercury*
  - *Muriate of Mercury*
  - *Mercury Chloride*
- Mercuric Iodide, 454.44
  - *Hydrargyri Iodidum Flavum*
  - *Hydrargyri Pro-Iodiret*
  - *Hydrargyri Iodidum Viridi*
  - *Yellow Iodide of Mercury*
  - *Yellow Mercurous Iodide*
  - *Subiodide of Mercury*
  - *Proto-Iodide of Mercury*
  - *Protiodide of Mercury*
  - *Brilliant Scarlet*

- Mercuric Iodide, 327.52
  - *Hydrargyri Iodidum Rubrum*
  - *Hydrargyri Biniodide*
  - *Deuto-joduretum Hydrargyri*
  - *Biniodide of Mercury*
  - *Red Iodide of Mercury*
  - *Red Mercuric Iodide*
- Mercury Sulfide, 232.67
  - *Hydrargyri Sulfidum*
  - *Ethiop's Mineral*
  - *Cinnabar (native)*
  - *Factitious Cinnabar*
- Mercuric Oxide, 216.60
  - *Hydrargyri Oxidum Flavium*
  - *Hydrargyri Oxidum Rubrum*
  - *Mercurius Corrosivus Rubr*
  - *Red Oxide of Mercury*
  - *Red Mercuric Oxide*
  - *Red Precipitate*
  - *Yellow Oxide of Mercury*
  - *Yellow Mercuric Oxide*
  - *Calcined Mercury*
  - *Monoxide of Mercury*
- Mercurous Oxide, 417.20
  - *Hydrargyri Syboxidum*
  - *Black Oxide of Mercury*
  - *Gray Oxide of Mercury*
  - *Suboxide of Mercury*
  - *Proto-Oxide of Mercury*
  - *Dioxide of Mercury*

Civilian Workers Wanted for Ordnance Department

Men having a high school education, some shop training and the natural ability to adapt themselves to new work, may qualify for a Government appointment in which under Government instructors, they will receive the necessary training for the positions described below. Those who have the required technical training will be placed and advanced as quickly as their ability justifies.

Which One of These Jobs Suits You?

Inspectors and assistant inspectors, field artillery ammunition steel.

Inspectors artillery ammunition, cartridge cases, assembling, loading, forging, primers, detonators, shell and shrapnel machining.

Ballistic inspectors.

Metallurgical chemists and assistants.

Inspectors, powder and explosives.

Inspectors, cannon, forging operations.

Inspectors, gun carriages and parts.

Inspectors, gun fire control instruments.

Assistant inspectors, motor vehicles and artillery wheels.

Engineers and assistant engineers, for tests of ordnance materials.

Inspectors ammunition packing boxes.

Machinists, accustomed to work to 1000's of inch.

Send in your own application and urge your associates who may be qualified to do so. These positions are under civil service regulations, but applicants will not be required to report for examination at any place. Applicant will be rated in accordance with education and general experience. No applications will be accepted from persons already in the Government service unless accompanied by the written assent of the head of the concern by which the applicant is employed. Papers will be rated promptly and certification made with least possible delay. Apply or write for further information to C. V. Meserole, Special Representative of the Ordnance Department, U. S. A., Room 800, 79 Wall Street, New York City.

NEW PUBLICATIONS

"Polarimetry"

This Bureau of Standards circular presents a concise account of the basic principles of modern polarimetry. The rapid growth in the applications of polarimetry in the arts and sciences has caused an increased demand on the Bureau for testing and research. The new edition of this circular contains ten new tables, including the new Bureau of Standards Baume scale for liquids heavier than water. Results of recent researches are also given. There is added a considera tion of the polarization of low grade products, a resume of the work of the international commission for uniform methods of sugar analysis and amendments to the United States Treasury Department sugar relations.

This paper is now ready for distribution, and those interested may obtain a copy by addressing a request to the Bureau.

New Publications of the U. S. Bureau of Mines

(List 57.—April, 1918.)

BULLETINS.

Bulletin 137. The use of permissible explosives in the coal mines of Illinois, by J. R. Fleming and J. W. Koster. 1917. 110 pp., 8 pls., 17 figs.

Bulletin 148. Methods of increasing the recovery of oil from sands, by J. O. Lewis. 1917. 128 pp., 4 pls., 32 figs.

Bulletin 159. Abstracts of current decisions on mines and mining, by J. W. Thompson. 1917. 111 pp.

TECHNICAL PAPERS.

Technical paper 141. Laboratory determination of the inflammability of coal dust and air mixtures, by J. K. Clement and C. N. Lawrence. 1917. 35 pp., 1 pl., 15 figs.

Technical paper 155. Gypsum products, their manufacture and uses, by R. W. Stone. 1917. 67 pp., 9 pls., 10 figs.

Technical paper 162. Initial priming substances for high explosives, by G. B. Taylor and W. C. Cope. 1917. 32 pp.

Technical paper 181. Determination of unsaturated hydrocarbons in gasoline, by E. W. Dean and H. H. Hill. 1917. 25 pp.

Note.—Only a limited supply of these publications is available for free distribution, and applicants are asked to co-operate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers cannot be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

The Amylo Saccharification Process

(*Concluded from page* 207.)

found very efficient) and the filtered solution again concentrated to incipient crystallization or left in a syrupy consistency. A corn cob extract is preferably added when put up for table use. The product thus obtained has a very fine flavor, due principally to the fact that when saccharification is quite rapid, a great deal of the sugar is present as maltose.

Washington, D. C., Feb. 2, 1918.

The Physical Basis of Color

(*Concluded from page* 218.)

acting transmitted waves is small, and the molecule is therefore not set in such strong vibration, although in many cases (fugitive colors) even this is sufficient to produce decomposition. On the other hand, a dyestuff fast to light must possess a stable molecule capable of absorbing light waves of large amplitude and of being set in strong vibration thereby without destructive action. Large molecules of simple symmetrical structure, without reactive side chains and substituents, particularly fulfil these requirements. In such a case the increase in size of the molecule through chemical action with the fibre produces favorable results, as is the case in wool dyeing. The physical nature of cotton dyeing precludes such a stabilizing action, and other methods are necessary. For example, the stabilizing action of combination with metallic oxides or of after-treatment of dyed material with copper salts."

Sulfite Pulp Waste as Raw Material for Dyestuff Production

Much study has been devoted to the problem of utilizing the vast amounts of waste sulfite lye resultant from the manufacture of wood pulp for use in paper making. The quantity of these waste liquors is such that they constitute a growing source of pollution for streams and rivers. It is estimated that the annual waste from American pulp works exceeds three billion gallons.

Of recent years not a few attempts have been made to employ the material in the production of dyes, and several patents have been granted to processes having this end in view. Pulp waste contains considerable amounts of a complex organic substance termed variously lignone, lignior and lignose. This substance is susceptible of being changed into coloring matters by two different methods.

The first is based upon fusion with sulfur and sodium sulfide. The resultant black and brown dyes are quite fast. They are probably closely allied to Cachoude Laval, also produced from the action of sulfur and sulfides upon a variety of forms of organic refuse, mainly containing cellulose.

The second method involves the nitration of the material either alone or after combination with various aromatic amines. The colors obtained range from light yellow to dark brown, and they are exceedingly fast after treatment with copper or chromium salts.

While there seems to be no question of the value of the dyestuffs and their availability for diversified use, the cost of production may prove to be a serious obstacle to any general use. The dilution of the waste lyes is often such that the expense attendant upon evaporation might alone exceed the cost of competing colors now on the market. In some pulp works, the amount of water is restricted, the lyes are more concentrated and waste steam is available for evaporation. Under such conditions it is quite possible that the dyes from lignone may be produced at favorable rates and may afford a welcome addition to coloring materials of purely domestic origin.

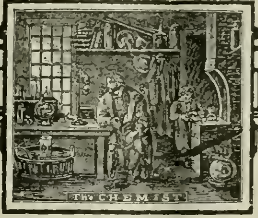
In this connection the statement is made that a paper-mill chemist in Finland claims he is able economically to produce methyl alcohol, cymol, and furfurol from sulfite lyes. He has taken out patents in Scandinavia, Russia, and Switzerland, and this has been followed by the starting of a color factory in Tammersfors, the centre of the Finnish textile industry. Here in the Technical Club, Dr. Wiljanen read a paper explaining this novel invention, and exhibited about ten different colors produced from cymol, and numerous others containing cymol as a substantial part. The lecturer claimed that about 300,000 kilos of cymol are obtainable annually in Scandinavia as a by-product. From this material yellow and red cotton and wool colors were producible in a simple manner, and other colors by more complicated methods. Finland's largest paper-mill association, Kymmene Aktiebolag, has installed apparatus in its sulfite factories for separating wood spirit, cymol, and furfurol, and research chemists in the new factory in Tammersfors are continuing the investigation. They are preparing to start in the near future the manufacturing of cymol colors.

Million Dollar Potash Corporation.

The Atlantic Potash Corporation has been incorporated at Dover, Del., with a capital of $1,000,000 to manufacture potash and chemicals.

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.



ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

S. B. S.—According to the "Patents and Designs Bill" presented to the House of Commons on November 19, 1917, the inventor is expected to work his invention within four years, otherwise it will be subject to compulsory licences.

A. L.—Am pleased to know you have disposed of your chemicals and colors to the industries I mentioned in my last letter.

The working formula for the manufacture of methylene violet will be ready to forward to you in a few days.

C. A. B.—Your paper pulp on chemical analysis is found to consist of cotton and wood fibres. There is too high a content of resin and the starch reaction is also too pronounced.

Your alkali digestion has not been carried to the required point; also your washing process is very defective.

I would strongly advise you to ship me samples from the next few batches so that I may detect the source of your further troubles, should any arise; also to enable you to put out a more uniform product.

G. O. M.—Any product you wish to forward me for chemical analysis and reproduction will receive my individual attention. And as I mentioned in my letter, I am in a position to supply working formula and type and size of all chemical plant required.

D. T. A.—The readily oxidable mass you sent me is a pyrophoric cerium alloy, containing approximately 75% cerium. The cerium used for this type of alloy should be free from lanthanum, neodymium and proseodymium. If you wish to obtain an alloy of cerium and iron, having a eutectic point, the iron ingredient should not exceed 5%.

T. S. A.—Since your products contain tannin, convertible into black iron compounds, and since I find that your artesian well water is contaminated with ferric oxy hydrate, would advise your treating this water with sodium carbonate, which will not only remove this iron salt, but will also soften it and prevent the trouble you now have from incrustation in the boilers.

W. A.—All questions are answered free of charge unless they require special investigation, in which case only a small fee commensurate with the work involved will be asked.

No charge will be made for the matter you mention in your letter of recent date.

T. R. S.—Cellulose xanthate was discovered by Cross, Bevan and Beadle in 1892 and forms the basis for what is known as "Viscose Silk."

It is produced by the action of sodium hydrate, carbon disulphide, on cellulose. On dissolving this in water a golden brown syrup is obtained.

Their chemical formulae are expressed as:

$$\begin{array}{ll} (\text{Cell}) & \\ & \text{CS} \\ \text{NaS} & \end{array} \qquad \text{And} \qquad \begin{array}{ll} (\text{Cell}) & \\ & \text{CS} \\ \text{NaS}^2 & \end{array}$$

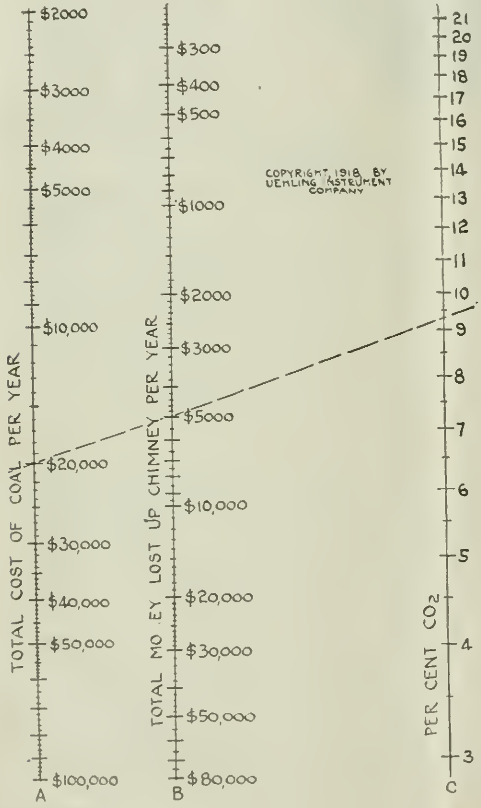
G. A.—The refrigerating apparatus and method you refer to in your last letter are protected by U. S. Patent 1,230,482, of June 19, 1917. Water is admitted intermittently to a vessel and caused to flow backwards and forwards in it. A current of air flows between the surface of the liquid and a parallel rotating surface, close to it, to vaporize the liquid. Air and vapor are then withdrawn by an exhauster; the vapor is condensed, and the air returned to the vessel.

Charles B. Davis.

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail are specifically requested, communications can only be considered in the order of their receipt.—Editor.

This Chart Shows the Money Lost Up a Chimney

This handy and useful chart has been developed by the Uehling Instrument Co., New York. It is of unusual interest and value at the present time when the coal problem is so important, for it enables anyone to quickly and closely estimate the money now being lost up almost any chimney due to low CO_2.



Simply connect the percentage of CO_2 (shown in column C) with the money now being spent per year for coal (shown in Column A), and the intersection of the connecting line with column B immediately gives the dollars rolling out of the chimney in the form of heated gases.

Example: If $20,000 is spent per year for coal burned in a furnace whose average CO_2 registers 9.3%, what is the approximate money lost up the chimney per year?

Solution. Connect the $20,000 (column A) with the 9.3% (column C) as indicated by the dotted line drawn across this chart, and the intersection with column B shows the approximate yearly loss to be $5,000.

The object of this chart is to show that a high percentage of CO_2 is most desirable. To be sure, even where the CO_2 is as high as 21%, the theoretical maximum there is a loss, because in the average power plant the flue gases leaving the boiler have a temperature as high as 500 or 600° F. Loss therefore is inevitable unless a blower is used for exhausting the gases and some sort of interchange system is installed for either heating the feed water or preheating air and leading it under the grate.

It is well to know all about these various things and the Uehling Instrument Co. advises that its engineers will gladly co-operate in whatever way possible with responsible concerns to secure maximum returns from every dollar invested in coal. Being combustion specialists, the advice of the Uehling people will be of particular value in showing how to attain the highest possible percentage of CO_2. It should be borne in mind that combustion is a chemical process and for that reason should be studied from the viewpoint of the chemist.

It is significant that most of the large power plants of today have adopted CO_2 instruments that record automatically and continuously. The reason for this is to keep constant tab on the workers in the boiler room and the efficiency of combustion. The recorder may be placed at any convenient distance from the boiler in the office of the chief engineer, owner, manager or superintendent, while an auxiliary CO_2 indicator is placed on the boiler front in full view of the fireman. The function of the indicator is to keep the fireman constantly informed as to the efficiency of his own work. This feature is most commendable.

Coal cannot be saved by a CO_2 machine alone. If no attention is paid to the indicator or recorder, the installation of such apparatus borders on foolishness. The records should be carefully watched and studied and adjustments should constantly be made in firing methods until the best percentage of CO_2 is obtained. After the best mark is reached, fluctuation of the CO_2 line below that mark to any great extent should not be allowed.

This chart is based on a flue gas temperature of 600° F., and an outside air temperature of 60° F. Where the flue gas temperature is higher, or the outside air temperature lower, the money loss will be correspondingly increased. On the other hand, with a higher outside air temperature and a lower flue gas temperature, the money loss is proportionately decreased. Further, in the construction of this chart, it has been assumed that the coal has a calorific value of 14,500 B.t.u. per lb. of combustible.

It may also be interesting to point out that where there is only 3% of CO_2 in the flue gases, 76% of the heat value of the coal passes up the chimney as waste under the conditions outlined above. It is impossible, however, for these gases to contain as low as 2%, because it would require more than the original quantity of heat in the coal to heat the enormous surplus of air to a temperature of 600° F.

FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Rubber Goods.

26485.—An agency is desired by a man in France for the sale of rubber goods, and food products. Correspondence should be in French. Reference.

Sheet Celluloid.

26475.—An agency is desired by a man in Canada for the sale of white, opaque, and transparent sheet celluloid for making protractors, scientific instruments, and for advertising purposes. References.

Sulphur.

26086—A man in Portugal desires to purchase sulphur. Quotations should be made f. o. b. New York. Payment will be made against documents. Correspondence may be in English. References.

Metals and Chemicals.

26307—An exclusive agency is desired by a man in Italy from manufacturers of typewriters, adding machines, office supplies, calculating machines, metals, and chemicals. Reference.

General Chemicals.

26321.—A firm in Brazil desires to be placed in communication with American manufacturers and exporters of chemicals of all kinds. Samples, complete price lists, and full information should be submitted.

Natural Dyes.

26077—A man in France desires to purchase dyes derived chiefly from dyewoods, such as campeche, indigo, aniline, and others. Samples, catalogues, and price lists should be submitted. He would consider an agency proposition. Quotations should be made f. o. b. New York. Correspondence should be in French. References.

Dyes and Lubricating Oils.

26393.—An agency is desired by a man in France for the sale of dyes, lubricating oils, greases, leather, imitations of leather, steel, tin, twines, pipes, valves and fittings, wagons, petrol and paraffine, paper, and other products of common use. He will also make outright purchases, if necessary. Correspondence should be in French. Reference.

Chemical Products.

26441.—An agency is desired by a man in France for the sale of chemical products, metallic ores and heavy metals. Correspondence may be in English. Reference.

Coke Ovens and Accessories.

26396.—A man in France desires to purchase coke ovens and accessory apparatus for treating and compressing carbonic acid, a by-product of the combustion. Correspondence should be in French. Reference.

Chemical Products.

26416.—An agency is desired by a man in France for the sale of mechanical tools in general, sheet iron and piping, wrought iron, bolts, pins, etc., agricultural implements and tools, chemical products, in general. Correspondence should be in French. Reference.

Edible Colors, Chemicals.

26451.—A company in Canada desires to secure an agency for the sale of chemicals, hog stomach linings, calves stomachs, edible colors, tallows, greases, and bones. Quotations may be made f. o. b. point of shipment. Correspondence may be in English. Reference.

Sodium and Potassium Nitrates; Organic Acids.

26452.—A man in France desires to purchase or secure an agency for the sale of nitrate of soda, nitrate of potassium, superphosphates, dried blood, sulphate of copper, verdigris, tartaric acid, and citric acid. In case of purchase cash will be paid. If agency is granted, security will be given. Correspondence should be in French. Reference.

Various Chemicals and Leathers.

26317.—A business man in Norway, who will be in the United States until April 15, desires to secure agencies for the sale of chemicals of all kinds, leather of all kinds, and raw cotton. He desires, especially, to establish connections at the present time for the conduct of business at the close of the war. Payment will be made by cash against documents. Correspondence may be in English. References.

DISTILLATES

News Notes of Chemical and Allied Industries

New Aniline Works.

Colonial Aniline Works has been incorporated at Monticello, N. Y., with a capital of $10,000 by P. S. Glickstein and W. N. C. Loewenthal of Brooklyn.

Lieut. Davison Constructing Plant.

Lieut. A. W. Davison has been transferred from Washington, D. C., to Niagara Falls, N. Y., where he is supervising chemical plant construction at the works of the Oldbury Electro-Chemical Co.

Dr. Carruth Makes Change.

Dr. F. E. Carruth, who was formerly with the chemical division of the North Carolina Experiment Station, has become associated with the Schaefer Alkaloid Works, Maywood, N. J.

Lieut. Files Now Instructor.

Lieut. Ellery K. Files, of the Gas Defense Service, has been transferred from Washington to Yaphank, L. I., where he will act as an instructor at the National Army camp.

Managerial Duties for Frye.

Following the retirement of Robert C. Schroth, Jr., as president and manager of the Laboratory Supply Co., Columbus, Ohio, Paul W. Frye, secretary and treasurer of the company, is now acting manager also.

Huntington Studying Acids Situation.

W. D. Huntington of Baltimore, Md., who was recently elected chairman of the Acids Committee of the Chemical Alliance, Inc., has been spending several days each week in Washington in the interests of the committee.

Diamond Black Dyeing Co.

The Diamond Black Dyeing Co. has been incorporated at Passaic, N. J., with a capital of $10,000 by Isaac H. Lefkowitz, Frank McFadden, Alexander Black, of Brooklyn, and Peter Bippus of Astoria, N. Y.

$2,000,000 Oil Co. Incorporated.

With a capital of $2,000,000 the Hercules Oil Co. has been incorporated under the laws of Delaware by W. F. O'Keefe, G. G. Steigler and J. H. Dowdell of Wilmington.

Government Acetone Plant for New York.

Acetone for aeroplane wings will be manufactured by the U. S. government at Mechanicsville, N. Y., in a new chemical plant to be erected at a cost of $1,000,000. The plant will utilize by-products from the West Virginia Pulp & Paper Co.'s plant near by.

Blue Ridge Paint & Color Co.

The Blue Ridge Paint & Color Co., Allentown, Pa., has been incorporated with a capital of $10,000 to manufacture paints, varnishes, etc. A. W. Thompson is the principal incorporator.

Whitney Machine Co.

The Whitney Machine Co., Winchester, Mass., has been incorporated with a capital of $100,000 by Arthur E. Whitney, Robert F. Whitney and Walter C. Goddard, Winchester.

Stanfield Acquires Zinc Mines.

The Monkey Hill Zinc Mines, Kingdon Springs, Ark., have recently been acquired by E. N. Stanfield, Oklahoma City, Okla., who is planning for extensive developments.

Denver Concern to Rebuild.

Work will be started at once by the Chemical Products Co., Denver, Cal., to rebuild that portion of the plant which was recently destroyed by fire with an estimated loss of $50,000.

Butterworth-Judson to Build Addition.

At a cost of about $25,000 the Butterworth-Judson Corporation, manufacturers of chemicals, will erect a new one-story engine plant to augment its works in Roanoke St., Newark, N. J.

To Enlarge Plant.

The Philadelphia Paper Mfg. Co., Philadelphia, Pa., will spend $25,000 for extensive alterations and improvements to its plant to provide for increased business.

Chemical Preparations.

The Altrex Co., Chicago, Ill., has been incorporated under the laws of that state to manufacture chemical preparations. The incorporators are Chas. F. Brandel, Jas. E. Rainey and Walter Bashong.

Chemical Compounds.

To manufacture chemical compounds, etc., the United States Sanitary Products Corp. has been incorporated under the laws of Illinois with a capital of $100,000.

Brown, Saal Co.

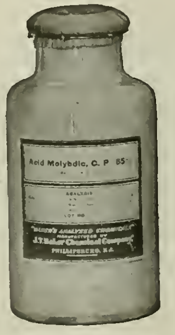
To engage in the manufacture of chemicals and allied products, the Brown, Saal Co. New York, has been incorporated with a capital of $10,000 by W. C. Murphy, D. H. Cory and J. E. Saal, New York.

On Your Next Chemical Order—

SPECIFY

"Baker's Analyzed"

Chemicals and Acids



After a trial you will specify them on ALL your orders, because you will find them dependable reagents of the highest quality and uniformity.

An Accurate Analysis Appears on the Label of Each Bottle

Catalog on Request

J. T. BAKER CHEMICAL CO.

PHILLIPSBURG, N. J.

Bring Us Your Dyestuff Problems

The application of dyestuffs to textiles is as important as their production. The technique of this branch of the color industry has for years commanded the best talent among those dyestuff distributors who have catered to the highest class of trade.

An intimate knowledge of the possibilities of every dyestuff is often necessary to meet the particular requirements of the consumer. Dyeing is a chemical, not a mechanical, process, and the variation of local conditions, due to differences in quality of water, steam and chemicals, makes the dyehouse problem an individual one.

Such problems are welcomed by the technical department of this company, which is manned by chemists who have been picked because of their knowledge, practical experience and demonstrated ability. We have long maintained well-equipped laboratories at our different offices for this purpose, and invite inquiries and extend, without any obligation on the part of our customers, our services to all who stand in need of them.

National Aniline and Chemical Company

INCORPORATED

21 Burling Slip, New York

THE CHEMICAL ENGINEER

VOL. XXVI. JUNE, 1918 No. 7

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

THOMAS H. NORTON, Ph.D., Sc.D.
LAURANCE T. CLARK,
Editors.
CHARLES B. DAVIS, F. C. S., Consulting Editor
H. C. DAYCH, Business Manager

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, JUNE, 1918

Note—Due to the omission of an issue of THE CHEMICAL ENGINEER dated for May, subscribers will have their subscriptions extended one month, so that they will receive twelve issues for each yearly subscription.

A Chance to Spread the Truth—The Coal-Tar Products Census 243
The Chemical Possibilities of Natural Gas 245
Coal-Tar Chemistry Section 255
Edited by Thomas H. Norton.
  China as a Market for American Coal-Tar Colors 255
  The Toluene Supply 256
  Poisoning from Trinitrotoluene 258
  The Distillation Products of American Lignite 258
  The Manufacture of Dimethylaniline and Diphenylamine 259
Inorganic Chemical Synonyms. Part V 261
Elton R. Darling.
Technical Men Unite for War Work 262
Ultra Violet Light: Its Application in Chemical Arts. Part XIV 263
Carleton Ellis and A. A. Wells.
U. S. Tariff Commission Completes Coal-Tar Products Census 272
New Publications 273
  Protecting the Eyes from Injurious Radiations 273
  Report on Technology of Salt Making 273
  Portland Cement with High Magnesia Content 273
  New Publications of the U. S. Bureau of Mines 274
Chemical Investigation, Efficiency and Control 275
Conducted by Charles B. Davis.
Foreign Trade Opportunities 276
Distillates 277

A Chance to Spread the Truth—The Coal Tar Products Census

The digest of the U. S. Tariff Commission's census of coal tar products manufactured in this country during 1917, published in another part of this issue, will be read with the keenest interest by all who are in the slightest degree concerned with the advancement of the industry.

The outstanding, vital fact revealed is that American manufacturers have at least the long-hoped-for independence of foreign sources of supply practically within their grasp. While it is by no means to be supposed that the crisis is wholly past, or that we are as yet in a position to greet the thought of future competition with loud and derisive cackles, yet, from the standpoint of technical accomplishment the results are, perhaps, without parallel in industrial history. And certain it is that the American dyestuff industry is today able to stand upon its own feet and give effective battle against the threatened commercial onslaught.

At first blush the census would appear (to the general public) to indicate that the industry has "arrived." We are making, it says, as many pounds of artificial dyestuffs each year within our borders as we were wont to import each year before the war. In other words, we made nearly 46 million pounds here in 1917 where we imported nearly 46 million pounds in 1914.

Now this is the fact which will be blazoned forth in the newspaper headlines for the edification of the aforementioned and usually appreciative general public—which includes among its ranks the Patron of the Department Store. This means much to the future peace of mind of the dye manufacturer, for, if the reader of these headlines is careful and genuinely interested, he may read on and thereby learn that all is not gold that glitters. But the chances are that he has read much and often of the dye situation and has come, for reasons which will appear later, to regard all literature pertaining to it even as the now historic report of Mark Twain's death—greatly exaggerated! Therefore, there is a grand possibility that the headlines referred to will constitute the keynote and the essence of the general impression spread abroad.

The facts of the case, as further set forth in the detailed figures of the census, are that while the sum total of dyestuffs made here equals the former importations, yet in some instances the quantities of certain dyes produced here differs enormously from the quantities of these same dyes previously purchased from abroad. For example, the census shows that the quantity of synthetic indigo and the important alizarin and vat dyes derived from anthracene and carbazol was less than 3 per cent. of the quantity of these dyes formerly imported. This decrease in the total number of pounds of dyes available was, of course, offset by a corresponding increase in the production of other and less important colors.

This phase of the truth has long been known to the trade, but it happens to be the one phase which has most persistently escaped the notice of the public at large, who sought, in the face of optimistic reports from the manufacturers, an explanation of department store refusals to guarantee American colors. The seeker after knowledge was offered for consideration and reflection an apparent contradiction of facts, emanating from two distinct sources: (1) department store clerks told him, or her, that prices were up and American dyes could not be guaranteed because there was a great shortage and the colors obtainable were inferior to the German, and (2) he read that this country was making as many pounds of dyes as it formerly imported and that American colors were as good as the German.

The real reason for the unsatisfactory conditions, which was caused by the inevitable hiatus between the time of exhaustion of stocks of imported dyes left over when all shipments ceased and the time when the American manufacturers first began sending their products in quantities to the relief of the mills, has never been forced upon his understanding in such a way as to make it stick there long enough for him to explain the situation to one of his fellow creatures. Hence we have had a gradual weakening of confidence in public statements about the dye industry, partially buoyed up, it is true, by a patriotic willingness to believe anything good of it, but nevertheless resulting in the creation of a fertile field for German propaganda.

The dye manufacturers and the mill people know full well the makeshifts and artifices, the applications of certain dyes to fabrics for which they were never intended in the feverish desire to obtain results at any price, which followed as a matter of necessity and which must even yet, to a certain extent, obtain. It is an old story to them, but it is not an old story to the general public, despite all efforts to spread beneficent propaganda, and it is today furnishing the principal ground for the still alarmingly widespread belief that our manufacturers and chemists are going to prove unequal to their task.

This message must be driven home, once and for all, before it is too late, and the manufacturers and mill owners will do well to give the *modus operandi* their earnest consideration. Whether it can best be accomplished by advertising to or circularizing the department store heads, or by carefully worded statements to the press, or even by the maintenance of a publicity bureau charged with the task, is for them to decide. But the point is that they must get busy at once and see to it that fundamental facts, and not superficial conclusions, are what reach the public mind.

"Met. and Chem's." Loss.

R. C. Bergen, assistant editor of *Metallurgical and Chemical Engineering*, has resigned to go into chemical manufacturing work. He had been connected with that publication since 1915 and was formerly a chemical engineer with the Roessler & Hasslacher Chem. Co.

The Chemical Engineer wishes him every success in his new line of endeavor.

National Aniline in New Offices.

Following their determination to change headquarters, the entire personnel of the National Aniline & Chemical Co. are now installed in the company's own ten-story building at 21 Burling Slip, New York City. The company announces that in addition to consolidating and reorganizing its sales force, the business heretofore done by the Century Colors Corporation has been consoliated with the business and staff of the National concern, which owns the entire share stock of the Century Corporation.

The technical department of the National Aniline & Chemical Co. consists of the following: B. A. Ludwig, manager; Dr. Louis Joseph Matos, W. Ostern, W. R. Moorhouse, H. C. Merrill, Richard Doss and G. A. Schroeder.

Sidio Co. Opens New Factory.

The Sidio Company of America has opened a new factory in New York City for the manufacture of fused silica ware. Chemical engineers have found their large variety of funnels, breakers, trays, tubes, etc., of great assistance. A large portion of their product has already been contracted for by the government. The officers of the company are: F. H. Ruhe, President; W. Fensterer, Vice-President; G. H. Mueller, Secretary.

A New Chrome Brown.

A new fast Chrome Brown has been placed on the market by E. F. Drew & Co., Inc. (The H. G. McKerrow Department). This is made by the newly organized Knickerbocker Color Company.

It is of a rich, reddish brown character, requiring simply the addition of a slight toning of Alizarine Blue Black and the necessary admixture of white stock in order to give the regulation Government Olive Drab Shade. It is exceedingly fast to the specified light and fulling tests and is therefore an important contribution to the range of colors which are now being used for army cloths. It works either on a chrome mordant, with chrome in the bath, or on a top chrome method, and in addition to this gives an excellent mode shade of brown in an acid bath.

This is the first of a series of Chrome Colors to be made by this company on an entirely new method, and as it can be produced in quantity at a materially reduced scale of costs it will probably prove to be one of the most effective and least expensive colors on the market.

THE CHEMICAL POSSIBILITIES OF NATURAL GAS

By

Dr. J. B. GARNER *

In the early development of the natural gas industry little thought was given to faulty valves, gates, couplings, regulators and other appliances connected with the drilling, production, transmission and distribution of natural gas. A goodly proportion of the gas that was produced was lost for the reasons that the appliances used were faulty. The producer could easily see his potential profits dissipated into the air, and as the result of the situation, he was forced to go to the engineer to devise for him new and less wasteful methods of handling his gas. The value of the results of the work of the engineer along these lines was at once recognized because of the increased balance on the right side of the ledger. The producer was convinced that the engineer was a necessary adjunct to his business. Later on, when well pressures declined and it became necessary to install large compressing stations, gas cooling coils, etc., the need of the engineer became more and more apparent, because of the numerous mechanical and electrical problems which arose from the successful operation and maintenance of gas compressing stations. The most enterprising of these companies secured the services of highly trained as well as intensely practical scientific and technical men. There is no country on the face of the earth which is so highly specialized in the compression and transmission of high pressure gas.

A Valuable By-Product First Regarded as a Nuisance.

Simultaneously with the installation of machinery for the artificial compression of natural gas in order that it might be economically transported to market, there was a decided lowering of the pressure on the well. Perhaps as a consequence of the lowering of the well pressure it has since been discovered that some less volatile gas was obtained, and by the process of compression and the consequent cooling of the gas minor quantities of these less volatile hydrocarbons were sometimes deposited as liquid in the transportation lines. This usually took place in cold weather, and occasionally this liquid would collect at a low point in the line in association with quantities of water and would interfere with the transportation of the gas. At low temperatures the water would freeze and the result would be the bursting of the pipe line. Not only were large quantities of gas lost when this happened, but the service to the customers who needed the gas was interfered with at a particularly inopportune time. The deposit of these liquid hydrocarbons also sometimes injured the rubbers of the couplings to such an extent as to render it a nuisance to the producer. The producer therefore again consulted the engineer, and drips were devised in which the liquid deposited in the pipe line could be periodically removed without interfering with the transmission of the gas. The liquid hydrocarbons thus collected, when separated from the water, came to be known as drip gasoline. It was not obtained in quantities sufficient to render it an article of commerce, though quantities of it were sometimes sold to refineries.

The Work of Saybolt.

At about this time an enterprising and far-seeing chemical engineer, George M. Saybolt, conceived the idea, contrary to the general notion, that there might be enough of the heavier hydrocarbons existing in the form of vapor in natural gas to justify an effort for their commercial extraction in liquid form. Starting with this idea, Mr. Saybolt invented a method of extracting these vapors and engaged in a series of experiments under the auspices of a large natural gas producing company which interested itself in his work. The result of Mr. Saybolt's experiments was the conviction not only that gasoline could be extracted from natural gas, but that the process which he had invented was a highly successful one for that purpose. The first plant for obtaining gasoline by his method was installed and placed in operation in August, 1913, and soon another surprising fact was learned, namely, that the gasoline so obtained was one of a particularly high quality and different from any other then on the market.

You are all conversant with the growth and development of this remarkable natural gas gasoline industry. It is now perfectly apparent to any one connected with the natural gas industry that gasoline can be extracted in commercial quantities from natural gas and that adequate returns are to be had from the investment required. Ten years ago, however, the story was different. All of this progress, development and growth in this industry we owe to the pioneer efforts of the chemical engineer--George M. Saybolt.

Composition of Natural Gas.

Natural gas is composed almost entirely of paraffin hydrocarbons in varying proportions—methane, ethane,

---

* Extracts from a paper read before the annual meeting of the National Gas Association of America, at Pittsburgh, Pa., and published in the American Gas Engineering Journal.

propane, butane, pentane, hexane, heptane and octane. Nitrogen, carbon dioxide and helium may exist in small quantities. The first two of the hydrocarbons are fixed gases; that is, gases which liquefy only at very low temperatures and high pressures. Propane and butane are normally regarded as gases, but are intermediate in their properties between a true gas on the one hand and a true liquid on the other hand. Pentane, hexane, heptane and octane are normally liquids at atmospheric temperature and pressure. Most commonly methane is the predominating constituent and octane is the hydrocarbon, which occurs to the least extent in natural gas.

First Plant for Recovery of Natural Gas-Gasoline by Absorption Method.

I desire to direct the reader's attention, in the first place, to the processes which have for their purpose the separation of natural gas into its constituents; in the second place, to the chemical changes which natural gas as a mixture, or its constituents separately, will undergo when subjected to heat under varying conditions, and in the third place, to the change which the constituents of natural gas will undergo when subjected to chemical change in the presence of other substances with and without catalysts; and in the fourth place, to the valuable by-products which may be obtained by synthetic chemical reactions from the exhaust gas of gas engines.

Getting Amyl Acetate at Home.

Since August, 1913, when the Hope Natural Gas Company installed the first absorption gasoline plant for the recovery of gasoline from natural gas, the natural gas-gasoline industry has experienced a rapid and remarkable growth. There are in existence at the present time more than 100 plants in the United States with a conservatively estimated production for the year in 1918 of more than 90,000,000 gal. The extraction of gasoline by this method has in no way affected the value of natural gas as a fuel. It has made the production of natural gas more profitable; it has made the service to consumers more efficient, less interrupted and more satisfactory. It has been one of the most important factors devised or invented having to do with the conservation of our natural gas resources. Probably no other factor has been so noteworthy in this direction. It has not only utilized and saved that which was formerly wasted, but has enabled producers of motor fuel to meet the demands of the market for this material in a manner which would have been exceedingly difficult if at all possible in the present status of the oil industry. Petroleum distillates which of themselves are not utilizable as motor fuels are, when blended with natural gas-gasoline converted into satisfactory motor fuels. From the nature of the occurrence of gasoline as vapor in natural gas, one can readily understand why natural gas-gasoline contains relatively far more of the lower boiling hydrocarbons, pentane and hexane than is contained in refinery gasoline. It is the relatively large proportion of these two hydrocarbons that gives to natural gas-gasoline its greater value, and that has to the present time made it an article of great chemical importance.

At the outbreak of the present great world war, unusual chemical demands were made of American industry. One of the foremost of these demands was for explosives or munitions. Amyl acetate is extensively used in the explosive industries. Prior to the war, Germany furnished practically all the world's supply of this material. All that was made in America was made from amyl alcohol and acetic acid. A review of the patent literature discloses that there were numerous German patents by means of which this product could be prepared from pentane. American manufacturers, facing the shortage of this material, and knowing that the requirements would be great, went into the gasoline market, and asked that special cuts be made, so that they would be provided with sufficient pentane which they could utilize for the manufacture of this product. On account of the fact that the United States Government has been lax regarding exact disclosures in the patents granted, especially to Germans, it was necessary that American industry should employ skilled and competent chemists to endeavor to find a method by means of which amyl acetate could be manufactured at a reasonable cost and in sufficient quantities to meet present-day requirements. The work required of American chemists was rendered more difficult on account of the confusion which arose over incorrect disclosures in the patents already granted than if there had been no published data regarding any processes whatsoever. The whole ground had to be worked over thoroughly and carefully. As a result of the work of these chemists a process was invented, a plant was installed, and quantities of material adequate for all present-day demands produced. The Du Ponts at Wilmington, Del., have had in operation for two years a plant for this purpose. The process consists essentially of taking natural gas-gasoline and subjecting it to fractional distillation. The fraction which distills over at from 40 to 70 deg. C., and which is essentially a solution of pentane and hexane, is brought in contact with chlorine in the presence of ultra violet rays of light, until a certain amount of chlorine has been absorbed by this fraction. This chlorinated mixture is then subjected to a washing and distilling operation. In the distilling operation a fraction is selected whose chief constituent is amyl chloride, or pentane in which one hydrogen atom has been displaced by one chlorine atom. This amyl chloride is then mixed with sodium acetate and the mixture heated under pressure. Common salt and amyl acetate are the products of the change which occurs. The separation of these two compounds is readily and easily effected. Amyl acetate has the following commercial uses—solvent for pyrocollodion, collodion, photocotton and pyroxylene. Pyroxylene is used in the manufacture of artificial silk, imitation leather, waterproofing compositions, celluloid and photographic films. Pyroxylene lacquers and amyl acetate are used for metallic surface coverings.

The Demand for the Fatty Acids.

It appears to the writer that the chemical possibilities of hexane, heptane and octane are even greater commercially than those of pentane. One of the greatest of the demands made upon American industry, and, in fact, upon world industry since the beginning of this great war, is that of the fatty acids. The supply from living sources has not been equal to the demand, and industry, in order to meet the pressing requirements, has been compelled to look to mineral sources as a base of supply. Upon high authority the statement has been recently made, "It is not improbable that Germany to-day is supplying a large part of her fats from synthetic production, with mineral oils as a base of supply." It is entirely feasible by well-known and well-tested chemical reactions and methods of synthesis to prepare a fatty acid from these hydrocarbons that will have the same composition, same food value and same uses as the corresponding acid derived from natural fats. To have made the statement ten years ago that gasoline was a potential force in supplying a part of the food requirements of the nation would have been regarded as fanatical and impossible.

Benzol Formed by Chemical Change Which Occurs When Coal Is Heated.

Within the past year, many of the newspapers and most of the popular magazines have contained articles descriptive of the recovery from coal and coke-oven gas of benzol and toluol, and the manufacture from these substances of high explosives, important drugs and medicines, and a widely used coal-tar dye. These articles have appeared as a result of a desire on the part of the American people to learn of the demands which are being made upon American industry by the nations at war. Germany had formerly supplied practically the entire world with these substances, and when the German supply had been cut off, such a demand had been created that it was necessary that some nation not at war provide ways and means of meeting these requirements. Plants for the recovery of benzol and toluol from coke-oven gas have been installed throughout this country with such remarkable rapidity and on such a colossal scale that American industry can to-day, if called upon, furnish the entire requirements of these materials for the world on a war basis. The scientific investigation which preceded and has gone along with the development of this great American industry, shows clearly additional chemical possibilities which natural gas-gasoline may have. The mother substance of all the so-called coal-tar drugs, medicines, explosives and dyes is benzol. Benzol does not exist as such in coal from which coal or coke-oven gas is derived, but is formed by the chemical change which occurs under definite conditions when the coal is heated. It has been conclusively shown by a large number of chemists that when coal is caused to undergo chemical change at low temperatures, benzol or aromatic hydrocarbons are formed. I have mentioned previously in this paper that high-boiling paraffin petroleum distillates when heated to 500 to 550 deg. C. gave what is called "cracked" gasoline, and when heated to 650 to 750 deg. C. gave aromatic compounds. The writer has personally conducted experiments with propane and butane and the gasoline hydrocarbons under varying conditions of temperature in the presence of catalysts like nickel and iron, and found that benzol and toluol can be prepared from them. It seems therefore quite clear that if the proper time, attention and thought were put upon the problem, that a commercial process, economical and satisfactory, could be devised, whereby the hydrocarbons composing natural gas could be converted into benzol and toluol, or, in other words, if necessity required, natural gas-gasoline could be made the basis of the coal tar, drug, medicine, explosive, and dye industries.

Heavy Hydrocarbons.

It has long been noticed in the operation of absorption gasoline plants that there were heavy hydrocarbon vapors that were not condensed at atmospheric pressure by the condenser directly connected to the stills in the distilling operation. Early in the industry, these vapors were permitted to escape, either into the air or were passed into a low-pressure fuel line. Later on these vapors were collected and handled in a small compressor, and as a result of the compression and subsequent cooling, considerable yields of high gravity gasoline were secured. This practice is now a general one in absorption gasoline plants. The uncondensed gases from this tail house compressor have for the most part been either put into suction lines or into fuel lines. In some few instances, the compressor which is used on these vapors is a two-stage one, in which pressures of from 100 to 150 lb. are maintained on the discharge. When such compressors are used, the product produced in the second stage of the compression, or in the low stage if the pressure is above 50 lb., contains highly volatile liquid. If the liquid produced under such circumstances is trapped or blown off into run or storage tanks, the product undergoes weathering, which means nothing more or less than that the material is permitted to remain in the tanks until the highly volatile portion has evaporated. In the majority of these cases the weathering or evaporation products are permitted to escape into the air. This practice has been nothing more or less than criminal waste, for every producer of natural gas-gasoline has known that under no circumstances can this material be delivered to market in ordinary tank cars, and that although he has spent his money for equipment and power in producing it, he has received no financial return from it. It seems incredible that the commercial possibilities of extracting liquid by-products should have been unnoticed for so long a time.

Value of Butane Constituents.

As the natural gas-gasoline industry developed and its possibilities became well known, leaders in the natural gas industry, as a result of their studies in determining the best conditions of operation of gasoline plants, realized that there could be extracted from natural gas other by-products of a liquid nature, which were too highly volatile for use and shipment as gasoline. Recent discoveries have disclosed the utility and value of the propane and butane constituents of natural gas when they are substantially free from other constituents of the gas. A process has been devised for the recovery of these two substances in liquid form along with the recovery of gasoline from natural gas. The plant which will produce these two substances is made as an adjunct to the absorption gasoline plant. It can be easily and cheaply installed, and can be operated with very low operating cost as the operating conditions require no additional attention other than that which the men regularly employed on a gasoline plant can give to it without neglecting their other duties. One plant has already been installed for the manufacture of both liquid butane and propane. Since May 31, 1917, it has been possible to produce at this plant approximately 2,200 gal. of liquid butane and 2,000 gal. of liquid propane per day.

In practicing the process for the recovery of substantially pure liquid butane and liquid propane, the by-product vapors from the condenser consisting of a mixture of propane, butane, some pentane, hexane and fixed gases are passed under pressure under a definite set of conditions through an absorbent oil. This treatment is for the purpose of removing petane and hexane. The remaining vapors—substantially a mixture of propane and butane, are, under a given set of temperature conditions, subjected to pressure. This results in the condensation of a highly volatile liquid product from which liquid butane is commercially produced. The remaining uncondensed propane vapor is again subjected to a compressing and cooling operation, and a liquid portion is obtained, from which substantially pure liquid propane is obtained. The products as obtained by the process thus briefly described have the following average physical properties:

Liquid butane is a clear, colorless, mobile liquid with a gravity of 106 to 108 deg. B. at 32 deg. Fahr.; it has a heating value of about 3,400 B.t.u. per cubic foot. One gallon of the product when evaporated produces 37 cu. ft. of vapor when measured at 60 deg. Fahr. and atmospheric pressure. The gravity of the gas or vapor produced varies from 1.98 to 2.02, air equalling 1 The boiling point of the liquid at atmospheric pressure varies from approximately 29 to 34 deg. Fahr. The following temperature-pressure relations, when this product was confined in a steel cylinder, were found:

Degrees Fahr.	Pressure Gauge
44	55
60	65
71	83
81	98
92	112
103	129

Latent heat of evaporation at 1 atmosphere and 32 deg. Fahr. = 164 B.t.u. per pound.

Liquid propane is a clear, colorless, mobile liquid, gravity 128 to 131 deg. B. at 32 deg. Fahr. Heat value, 2,600 B.t.u. per cubic foot. One gallon of the product upon evaporation will yield 45 cu. ft. of gas or vapor at 60 deg. Fahr. and atmospheric pressure. The gravity of the gas produced is 1.51 to 1.54. The boiling point of the liquid at atmospheric pressure is approximately 49 deg. Fahr. The following temperature-pressure relations, when this product was confined in a steel cylinder, were found:

Degrees Fahr.	Pressure Gauge
47	438
59	453
70	470
81	500
91	524
100	555

Numerous practical and engineering tests have been made on both of these products. They have been found suitable for the lighting and heating of homes and buildings in regions remote from the gas fields. The ordinary commercial appliances in the way of burners and stoves have been used in these experiments. The readjustments which have been required in these common devices for the economical and satisfactory use of those products have been learned. Tests have been made with those gases as a source of power for stationary engines and automobiles. In the work of adapting these products for motor fuel purposes, the writer has had the hearty co-operation of Drs. Raymond F. Bacon and Harry Essex, of the Mellon Institute, and Mr. Barber, an experienced internal combustion engineer. The results of the work carried on clearly indicate and prove that not only can those substances be used with the ordinary equipment of internal combustion engines, but that the carburetor can be entirely done away with, and in its stead a gas mixer be used. The following road and maximum power tests will be of considerable interest:

RECORD OF ROAD TEST USING BUTANE AS FUEL JULY 9-10, 1917

Machine	Crawford 45 hp., using gas mixer in place of carburetor.
Weight	Empty 3,750 lb., loaded 4,750 lb.
Run consisted of	21 miles Pittsburgh city driving, 111 miles country-mountain driving.

Location of run	From Pittsburgh to the east side of Laurel Ridge (beyond Ligonier, Pa.) and return.
Gas supply	In three cylinders, containing 78 lb. of butane.
Total gas used	58 lb.
Total mileage	133 miles.
Miles per pound	2.3 miles.
Miles per gallon	11.5 miles.
Adjustments made	70.
Connections made	21.
Stops to change tanks, etc.	40.

Note.—Each stop necessitated readjustment and large loss of gas—unnecessary with proper tanks and purest gas.

Comparison with Gasoline.

The same Crawford car, equipped with Stromberg carburetor, on the same run with three stops gives 9.3 miles per gallon of 76 deg. gasoline.

With forty stops, and the same number of adjustments, the mileage would be less than 5 miles per gallon of gasoline.

In addition to this excellent mileage shown, the oil requirement was cut over 50 per cent. But 1 quart of oil was put into the system and not over ¾ quart used. Ordinarily with gasoline on this run, 2 quarts are necessary.

Remarks.

The run as recorded above was made on a very bad day. Rain fell hard for at least four of the ten hours time and the air temperature was from 52 to 60 deg., giving little chance for gasification by heat; also the roads was necessarily slippery.

The engine at no time failed to give the proper mixture and could be throttled down to 5 miles per hour on a 12 per cent. grade without stalling or missing a single explosion. This cannot be done with any four-cylinder car using gasoline.

In the maximum power tests which were conducted at the Mellon Institute, a Dodge motor was used. Various fuels were tested, and the total horsepower developed by all the fuels used did not vary from one another more than 1 per cent., or easily within the limits of experimental error. Carburetor adjusted and spark advanced to maximum power. The temperature of the exhaust gases varied from 640 as a minimum to 655 deg. C. as the maximum.

In our work with the stationary engines, we have found that 1 cu. ft. of propane is equivalent to almost 2¼ ft. of ordinary natural gas, and that 1 cu. ft. of butane is equivalent to approximately 3 cu. ft. of ordinary natural gas. This is the relationship which could have been anticipated from the relative heating values of the different products. In addition to the uses cited above for these by-product liquids, other important uses have been discovered and appliances for their satisfactory use commercially devised, namely, for the purpose of the cutting of metals and of incendiary bombs for offensive warfare work. The latter one of these uses will be omitted from the discussion of this paper for obvious reasons.

Fuel for Metal Cutting.

The credit for working out the details of the torch used for metal cutting is due to James and Harry Anderson, of the N. C. Davisson Burner Company. Liquid butane and liquid propane have both been successfully used by these same gentlemen for the welding of cast iron, aluminum and other metals. Work is in progress which has for its purpose the development of a torch which will enable these materials to be used for steel welding. The writer has every reason to believe that this torch will soon be available for sale on the American market. In accordance with the Interstate Commerce Commission specifications No. 6 for shipment of liquefied petroleum gas of not over 150 lb. charging pressures, cylinders may be used which are seamless, or of welded or brazed construction, and must show a test pressure of 600 lb. Butane does not require 150 lb. charging pressure. It is therefore possible to ship liquid butane in accordance with these specifications in cylinders which will weigh from one-eighth to one-third that of the cylinders now used in interstate commerce shipments of gases which are used for similar purposes. This gives butane a marked advantage in freight and express shipments. In addition, the cost of these cylinders should not be in excess of 40 per cent. of the other cylinders which are in use commercially.

Another added advantage in the use of butane is its remarkably narrow explosive range. The following may be of interest with reference to the explosive limits for mixtures of various commercial gases:

	Per cent. of gas
Natural gas	5.0 to 11.5
Methane	6.1 to 12.8
Coal gas	7.9 to 19.1
Acetylene	3.3 to 52.3
Hydrogen	9.45 to 66.4
Butane	3.0 to 8.0

It is clear from the above that butane is the safest to use of all commercial gases.

It is apparent from the above program that there are tremendous possibilities from the recovery and therefore the use of these liquids, highly volatile products of natural gas. A discussion of other possibilities of these substances is deferred to another section of the address.

Chemical Changes Which Natural Gas, as a Mixture, or Its Constituents Separately Will Undergo When Subjected to Heat.

Early in October of 1915 the writer, in connection with his assistants, began a preliminary study of the effect of heat on natural gas.

They made use of electrically heated fused quartz or Shelby steel tubes. Experiments were made both in the presence and absence of catalysts and the influence of these substances on the decomposition under temperature ranges of from 400 to 1,400 deg. C. studied. The catalysts used were pumice-nickel, pumice- copper, charcoal, finely divided copper, finely divided iron, aluminum, aluminum chloride, and silica. It was found that the decomposition, whatever took place in the presence of these catalysts, varied in a manner that was characteristic for each catalyst. For example, one catalyst, under a definite set of conditions, gave a high percentage of acetylene while another produced none.

There has been quite a lot of work done on the thermal decomposition of the paraffin hydrocarbons, but as far as the writer is concerned he is not aware of the industrial application of the results of the majority of this work. The patent, scientific and technical literature contains much information relative to the subject.

In the experimental work which the writer did the following products were used: (a) Natural gas as is delivered to the city of Pittsburgh; (b) vent tank gas; (c) propane, and (d) butane.

All of the samples of these gases were carefully analyzed and tested and their properties tabulated. The gases were then caused to pass through the apparatus provided for their study under varying conditions of temperature, pressure and rate.

In order that this paper may not be made tedious by the introduction of tabulations of results these have been omitted and will be published subsequently. It is sufficient, upon this occasion, to state that the experimental results were most gratifying in that the conditions of experimentation were learned whereby natural gas found chemical changes when subjected to heat under varying conditions. Carbon black, unsaturated hydrocarbons, of both the olefines and acetylene series, and hydrogen are the direct and only products which are obtained when one set of conditions is observed, while on the other hand, when another set of conditions is observed, in addition to the products mentioned, benzol, toluol, naphthalene, etc., are produced.

Industrial Application of Results.

The industrial application of the results of our experimental work has, so far, been confined to that set of conditions which had for its purpose the production of the greatest yield of the highest quality of carbon black. In the two plants which have been built the following are the representative results:

Kind of Gas	Ratio of Gas Passed to Gas Collected	Carbon Black Formed Lb. Per 1,000 Cu. Ft.	B.t.u. of Discharge Gas	B.t.u. of Inlet Gas	Per Cent. Unsaturated Hydorcarbon
Natural gas	1.27	4.52	840	1,142	6.75
Vent gas	1.42	6.44	861	1,347	12.9
Propane	2.63	26.9	866	2,600	26.2
Butane	2.99	38.2	702	3,400	26.6

It will be observed, first, that natural gas, as a mixture, gives a yield of barbon black three times as high as that usually obtained by the wasteful process of incomplete combustion, and that the yields from the other gases are far in excess of those obtainable from ordinary natural gas.

Second.—That the discharge gas is larger in volume than the inlet gas by ratios varying from 1.27 to 2.99. The heating value of the discharge gas is of necessity much lower in value than the inlet gas; however, the discharge gas has a heating value much superior to that of any artificial gas. The discharge gas is therefore a commercial one, and if carbon black is the only product desired this gas can be put into the usual channels for delivery to market.

Third.—That the discharge gas contains unsaturated hydrocarbons of the olefine series, mostly ethylene, and that the amount varies from 6.75 to 26.6 per cent. The olefine hydrocarbons are present in artificial gas, and in a large measure are responsible for its luminosity. If it is desired these unsaturated hydrocarbons may be used by simple chemical reactions for the manufacture of:

(a) Glycols.

(b) Industrial alcohol, acetaldehyde, acetic acid, acetone.

(c) Chlorinated olefine solvents.

It is well known in organic chemistry.

1. That members of the olefine series of hydrocarbons when treated under the proper conditions with potassium permangenate yields glycols.
2. That olefine hydrocarbons when treated under the proper conditions with sulphuric acid yield compounds which on treatment with water give alcohols and regenerate the sulphuric acid.
3. Olefine hydrocarbons when treated directly with chlorine absorb the chlorine chemically and yield chlorine derivatives.

The glycols are, as a general rule, thick, colorless liquids and have a sweet taste. They are miscible with water and alcohol in all proportions. Recently these substances have been utilized as substitutes for glycerin in the manufacture of medicine, drugs, explosives, etc.

The extensive commercial use of alcohol is too well known to need much discussion. The largest commercial uses of industrial alcohol are for solvent purposes. In the manufacture of organic dyes, varnishes, explosives, perfumes, tinctures, etc. Since the opening of the European war large demands have been made upon the alcohol industry for ether, acetaldehyde, acetic acid and acetone. All these substances may be obtained by simple well-known chemical reactions from industrial alcohol.

The chlorinated olefine derivatives have for the past few years been made in large quantities by other methods and have found extensive use in the rubber industry

I have pointed out above that carbon black and olefine hydrocarbons can be produced from natural gas or its constituents separately. I have further pointed out the chemical possibilities of the olefine hydrocarbons. If both carbon black and olefine hydrocarbons are recovered from natural gas and utilized in any of the ways mentioned above there is left a residue mostly composed of hydrogen. This residue can be easily converted into a practically pure product by subjecting it to heat at a temperature slightly in excess of 1,400 deg. C. The opportunity therefore is open for the manufacture of pure hydrogen from natural gas. Hydrogen, as is well known, is used largely in war times for balloon purposes; however, its largest peace time use is in the hydrogenation or hardening of oil. Tremendous quantities of cottonseed and other edible oils are readily converted by means of hydrogen in presence of nickel as catalyst into solid products or fats which have wide economic and industrial importance.

It can thus be seen that by the decomposition of the natural gas or its constituents separately, valuable products can be obtained which have almost unlimited possibilities.

Chemical Changes Which Natural Gas or Its Constituents Will Undergo When Subjected to Chemical Change in the Presence of Other Substances and Without Catalysts.

This section of the paper will be limited to the discussion of the chemical changes which occur when natural gas, or its constituents separately, are treated with the following reagents:

(a) Air, oxygen being the active component.

(b) Chlorine.

(*a*) *Reactions with Air or Oxygen.*

The use of material gas as a fuel is nothing more or less than the taking advantage of the heat evolved when natural gas reacts chemically with the oxygen of the air. The chemical change which occurs results in the conversion of the paraffin hydrocarbons of natural gas into carbon dioxide and water. The formation of carbon dioxide and water is the final result of a whole series of intermediate chemical changes. It is to these intermediate chemical changes that I desire to call your particular attention at this time. Considered from the theoretical viewpoint, methane, the predominating component of natural gas, should yield, when treated under the proper conditions with air or oxygen, the following substances: Methyl alcohol, formaldehyde, formic acid or carbon monoxide, carbon dioxide and water.

H. S. Blackmore, United States Patent No. 774,824, of Nov. 15, 1904, claims to have invented a process whereby methane when heated under a temperature of 260 deg. Fahr. with various metallic oxides as a source of oxygen obtains from 1,500 cu. ft. of methane, 125 lb. of methyl or wood alcohol, and at a temperature of 315 deg. Fahr., from 1,500 cu. ft. of methane produces 118 lb. of formaldehyde. The metallic oxide used as a source of oxygen were ferroso-ferric oxide, cupric oxide, and manganese and barium dioxides.

In United States Patent No. 891,753, another investigator has found that when methane is treated at temperatures from 86 to 122 deg. Fahr., with air in the presence of oak bark as catalyzer, he obtains from less than 1 cu. ft. of methane slightly less than 4 lb. of formaldehyde. He also claims that small quantities of methyl or wood alcohol and formic acid are produced. An abstract of this work may be found in the *Journal of the Society of the Chemical Industry*, Vol. 27, page 918.

Glock, in German Patent No. 109,014, claims that methane and air in equal volumes when passed through a tube containing granulated copper as a catalyst yields at a temperature of 112 deg. Fahr. formaldehyde in commercial quantities. Numerous other investigators, as Otto, Coquillon, Bone and Smith, and Bone and Wheeler, have made similar observations, viz., that methane in the presence of air and catalysts at certain temperatures yields formaldehyde.

Dennis and Hopkins, in the *Journal of the American Chemical Society*, Vol. 21, page 309, gives a description of a laboratory method of converting methane into carbon monoxide.

The writer has personally investigated the conversion of methane into carbon monoxide and finds that under the proper conditions, to wit: (a) Relative values of methane and air interacting; (b) presence of certain catalysts; (c) definite rate of flow, and (d) carefully regulated temperatures; that it is possible to convert methane into more than 90 per cent. of the theoretical quantity of carbon monoxide. This particular phase of the chemistry of methane was studied on account of the commercial importance of the following products which can be derived from carbon monoxide by simple chemical changes; (1) Carbonyl chloride or phosgene; (2) formic acide, and (3) oxalic acid.

Carbonyl chloride is used very extensively at the present time in offensive gas warfare and in the synthetic dye industry. It command a price which is quoted as nominal. This means that the product is difficult to obtain and then only at a good price. Formic and oxalic acid find ready sale at from 35 to 45 cents per pound in large containers.

Lemoine and Senderens, working independently, in 1907 found that when carbon monoxide and chlorine in equal volumes are passed through a suitably constructed apparatus containing wood charcoal as catalyst, react to produce quantitatively carbonyl chloride or phosgene. This is the commercial method of manufacture.

English Patents Nos. 4,684 and 9,008, French Patents Nos. 342,168 and 421,227, and numerous scientific articles describe processes for the manufacture of the salts of formic acid. These processes in the main consist of passing carbon monoxide in the presence of various catalysts at different temperatures into caustic soda, caustic potash and quick lime under some pressure to produce the salts of formic acid. These salts by simple treatment with sulphuric acid yield pure formic acid. This acid is manufactured on a large scale in Germany by this process.

If the salts of formic acid as prepared by the methods just given are heated to temperatures ranging from 680 to 770 deg. Fahr., these undergo chemical change resulting in the production of pure hydrogen and the salts of oxalic acid, from which oxalic acid can be derived by treatment with sulphuric acid. German Patent No. 229,853 is a description of a process wherein 1 per cent. of borax or 5 per cent. of boric acid is used as catalysts. The optimum temperature is as given above and the yield is 88 per cent. of the theoretical. German Patent No. 269,883 is a description of a process for the manufacture of oxalates from formates wherein the best temperature is given as 725 to 752 deg. Fahr. V. Merz and W. Weith, in *Berichte*, Vol. 15, page 1513, describe a process whereby sodium formates when heated out of contact of air at a temperature of 752 deg. Fahr. is converted into 70 per cent. of the theoretical quantity of oxalate.

The above instances of the chemical changes which occur when methane is burned either in the presence of air or oxygen, are given for the purpose of showing the state of the art. The speaker feels that it is entirely possible to develop commercial processes whereby the following substances may be produced from natural gas: Formaldehyde, formic acid, oxalic acid and carbonyl chloride.

(*b*) *Reactions with Chlorine.*

Since 1879 a great many chemists have devoted much time to a study of the problem of the chlorination of natural gas. Mallet has two patents on this subject—United States Patents Nos. 220,397 and 880,900. Professor Francis C. Phillips, of the University of Pittsburgh, has published more or less extensively on this subject in the *American Chemical Journal*. Elworthy holds French Patent 35,291 and German Patent 222,919, covering processes on this subject. Baskerville and Hamor, of the College of the City of New York, have done more or less extensive work in this field. McKay holds United States Patent 1,009,428. The subject, therefore, is one which has received more than passing attention. The industrial application of the reactions and processes described in any of the above mentioned literature or patents has not been made. In the fall of 1915 the speaker in conjunction with his assistants took up the study of this problem. The natural gas which was used was that furnished by the Equitable Gas Company to the Mellon Institute of the University of Pittsburgh. The chlorine used was liquid chlorine produced by the Electro Bleaching Company, of Niagara Falls, N. Y. The conditions of experimentation were varied from time to time until optimum conditions of operation were learned. It was found that when a mixture of natural gas (5 cu. ft.) and chlorine (4 cu. ft.) was passed through a tube at a temperature of from 518 to 554 deg. Fahr., using clay, pumice, infusorial earth, or luminum chloride as catalysts, that a reaction occurred smoothly and regularly, resulting in the production of the following substances: Methyl chloride, methylene chloride, chloroform, carbon tetrachloride and muriatic acid, together with small quantities of complex chlorinated hydrocarbons. Using the data derived from the laboratory work it was found by calculation that 1,000 cu. ft. of natural gas when treated with 526.4 lb. of chlorine will give:

51.34 lb. carbon tetrachloride, worth 15½ cents per pound.
189.8 lb. chloroform, worth 75 cents per pound.
62.86 lb. methylene chloride, market price nominal.
13.06 lb. methyl chloride, market price nominal, and
567.00 lb. muriatic acid, containing 37.9 per cent. of hydrogen chloride, worth 1¾ cents per pound.

Both methylene chloride and methyl chloride can be easily converted into chloroform and carbon tetrachloride by another simple reaction, using metallic iron or ferric chloride as catalysts and the yields of chloroform and carbon tetrachloride increased.

Chloroform a By-Product.

There are many gas fields in the United States and Canada which are not only remote from market, but which contain more than 9.5 per cent. methane, and would thus be suitable for the manufacture of chloroform, carbon tetrachloride and muriatic acid. In consideration of the fact that practically all of the chlorine on the market today is manufactured at points where there is cheap power, and that the gas spoken of is in regions remote from market, it would be necessary for any natural gas producing company manufacturing these chlorinated products to install a plant for the manufacture of chlorine. Caustic soda and hydrogen in large quantities would be produced by by-products, and these in turn would have to be disposed of or utilized profitably at the point of production. The success of industrial Germany along chemical lines is due to the fact that wherever an industry has been established and there are by-products resulting from this industry, additional processes have been installed or invested whereby nothing but finished products is obtained.

In other words, a program has been outlined which enables anyone owning natural gas in regions isolated or remote from market to install a series of processes by means of which all the natural gas can be utilized in a highly important and commercial way.

Not only have the chlorination reactions of natural gas, as a mixture, been studied, but particular attention has been paid to the chlorination of butane. On account of the fact that butane is a mother hydrocarbon of the following substances, butyl chloride and butylene chloride, it is from these substances that a large number of important commercial products are obtainable theoretically. Butyl chloride should, under the proper conditions of chemical change, such as are well known in the laboratory, yield butyl alcohol, butyl aldehyde, butyric acid and dipropylkatone. Butyric acid is the fatty acid derivable by saponification from butter fat. Dipropylkatone is a product which has the same commercial uses as acetone and many other additional uses in the explosive industry. Butylene chloride upon treatment with alkalies yields a hydrocarbon known as butadiene. This hydrocarbon is of practical interest, as it is the one which is the basis of the artificial rubber industry. In the *Journal of Metallurgical and Chemical Engineering* of May 1, 1917, pages 513 to 518, can be found an article giving a rather comprehensive statement of the chemical changes required to produce artificial rubber from butadiene. British patent No. 15,254 gives two methods of producing artificial caoutchouc. The methods are as follows:

1. Butadiene dissolved in benzol is heated ten hours at 150 deg. C. for a number of days.

2. Butadiene condensed at a low temperature by means of ether and carbon dioxide is kept in an autoclave at 90 to 100 deg. C. for four days. In both cases the solvents, unreacted upon material and by-products, are distilled off in vacuo or by steam, and a rubber-like mass remains.

Harries, in the *Annallen,* 1911, pages 157 and 383, describes another method whereby butadiene or its derivatives are heated with sodium wire. The yield is almost quantitative and the product obtained may be vulcanized quite readily. British patent No. 26,550 claims an advantage over the Harries process by conducting the operation in the presence of carbon dioxide. Matthews, in British patent No. 2,070, effects the same change in the presence of sulphuric dioxide. The process of Matthews is essentially as follows:

Butadiene or its derivatives are heated with sodium wire in the presence of benzol. Liquid sulphuridioxide is then added to the cooled solution and the mixture warmed in a sealed vessel at 40 deg. C. After some time the vessel is opened, when the solution is found to be very viscous and in some cases set to a jelly. On removal of the sulphur dioxide the product will be found to be elastic and to resemble natural caoutchouc.

The products soluble by the various methods are elastic, easily soluble in the ordinary rubber solvents, and capable of vulcanization. Many scientists are at work endeavoring to discover a process whereby artificial rubber may be produced at a cost which will enable it to compete with the natural product.

Developing a Process for Making Artificial Rubber.

The present status of the artificial rubber industry is much more promising than the artificial indigo industry was in its inception. The demand for indigo was relatively small, while the demand for rubber products has grown with remarkable rapidity along with the automobile industry. It is not to be expected that a synthesis so difficult and complicated as that of rubber could be effected without a great expenditure of time, energy and money. The ground work has been well laid, and I believe that American industry, which is to be at once the servant and master of world industry, will not be found wanting in supplying all that is needed to develop a process for the production of rubber. Natural gas, with its content of pentane and butane, which compounds can be readily and easily isolated, forms the hydrocarbon basis upon which the artificial rubber industry can be built.

Valuable By-products from the Exhaust Gas of the Gas Engine.

About the middle of the Seventeenth century Robert Boyle made the following statement:

> "The air is a confused aggregate of effluviums from such different bodies, that, though they all agree in constituting by their minuteness and various motions one great mass of matter, yet perhaps there is scarcely a more heterogeneous body in the world."

These words forcefully impress the fact that air is a mixture of several different gases. Oxygen, nitrogen, carbon dioxide and the rare or noble gases, are the main components of the atmosphere. Generally speaking the following is the average percentage composition of air, by volume, nitrogen, 78.03; oxygen, 20.99; rare or noble gases, 0.95; carbon dioxide, 0.03. Of the rare or noble gases argon exists in the largest quantity, 1,000 volumes of air contain approximately 9.37 volumes or less than 1 per cent. of argon.

When air is mixed with natural gas, and this mixture exploded in a gas engine, the hydrocarbons of natural gas react with the oxygen of the air to produce carbon dioxide and water vapor. The other constituents of air do not undergo any chemical change. The exhaust from a gas engine contains, therefore, nitrogen, the rare or noble gases, carbon dioxide, and water vapor. It is to these substances that I would have you pay particular attention at this time. If the exhaust gas is cooled by passage through coils sprayed with ordinary water and then compressed to a pressure of from 25 to 30 lb., practically all, if not all, of the water vapor present would be removed as liquid water. The remaining gas after such compression could then be treated according to a French patent of George Claude, for the recovery of carbon dioxide. In principle this process consists in passing the gas containing carbon dioxide through a body of liquid water under pressure, keeping the gravity of the water at such a point that practically all of the carbon dioxide is dissolved by the water at the temperature and pressure used. The unabsorbed gases consist of nitrogen and the rare or noble gases. The water containing the carbon dioxide dissolved under pressure can flow to a suitably constructed apparatus in which the pressure is lowered.

The carbon dioxide thus evolved can be picked up by a compressor and liquefied, and as such sold on the market for all the purposes as carbon dioxide prepared in other ways. R. F. Brownlee and R. H. Uhlinger have American patents No. 1,150,337 and No. 1,154,-

172, covering processes for the manufacture of carbon dioxide and nitrogen from natural gas.

In a preliminary report to the Ordnance Department of the War Department on the nitrogen industry by Charles L. Parsons, published in the *Journal of Industrial and Engineering Chemistry,* of September, 1917, pages 833 to 841, will be found a discussion of the methods utilized for the production of nitric acid and ammonia from the nitrogen of the air. Three of these processes—the Haber process, the cyanamid process and the cyanide process—all require practically pure atmospheric nitrogen.

The Haber process is a German one and consists of taking hydrogen and nitrogen and causing them to undergo chemical change at a temperatcre of about 500 deg. C. and at pressures from 125 to 150 atmospheres to form ammonia. This process is the one now mainly used in Germany. During the year 1917 the output by this process was equivalent to about 500,000 tons of ammonium sulphate. The ammonia obtained by this process can be oxidized and converted into nitric acid.

The cyanamid process is used quite extensively in both Europe and America. This process consists of heating calcium carbide to a red heat in the presence of nitrogen. The cyanamid produced is then powdered and mixed with sodium carbonate and lime, and the mixture treated with steam in large autoclaves to convert the nitrogen of the cyanamid into ammonia. In 1917 the German production of cyanamid was approximately 400,000,000 tons. Cyanamid is not only useful as a source of ammonia and ammonium compounds, but is well suited for use as a fertilizer when applied directly to the soil.

The cyanide process is, up to the present time, not a commercial success. The process consists of heating a mixture of sodium carbonate, ground coke or carbon in contact with finely divided iron to redness and then passing nitrogen through the mass. A reaction takes place rapidly, resulting in the formation of sodium cyanide.

Chemical Possibilities of Natural Gas.

It will be seen from the above that the nitrogen contained in the discharge gases from gas engines has many chemical possibilities in the production of compounds which are industrially very important.

Argon and the rare or noble gases, on account of the fact that these substances undergo no chemical change of any kind, will certainly be left in the residue gas after the recovery of carbon dioxide and the fixation of the nitrogen.

Raleigh was enabled to isolate argon and other rare gases from the atmosphere in 1893 by making use of the chemical inertia of these substances. Argon is a gas without color, taste or smell. It is incombustible and a non-supporter of combustion. Recently it has been shown that argon may find extensive use in the electric bulb industry.

The dawn of the day of the American industrial empire is upon us, and as the light of it breaks, the most splendid possibilities are revealed to us. In no field of commercial endeavor are its possibilties greater than in the industries having specifically to do with oil and gas. There are the possibilties of food for mankind and heat to prepare it for his growth and development. There is medicine to cure his ills and drown his sorrows; light to illumine his pathway and make it more cheery; materials to clothe, adorn and glorify the bodies of men. It is a most auspicious and prophetic time, and one which is worthy of the most serious and thoughtful consideration. It is the time above all times when men of vision and men of courage are needed. It is not an impossible time, but is one where the greatest of results may be realized if the efforts are properly directed. Subsidized chemical and engineering research is the keynote to the commercial realization of the possibilities of this age. The Natural Gas Men's Association can do its bit by entering upon a program of subsidized and heartily supported research.

Government Announces New Electric Furnace for Brass

Washington, D. C., May 31.—The U. S. Bureau of Mines today announced the perfection of a type of electric melting furnace that may be revolutionary in the making of brass. Patents of this furnace, known as the Rocking electric furnace, have been taken out by the bureau and have been assigned to Secretary of the Interior Lane as trustee. Free licenses to operate these furnaces under the patents, it is understood, can be obtained by making application through Van. H. Manning, Director of the Bureau of Mines.

The new furnace, which it is claimed will reduce the important losses in brass melting, is the result of five years' experimentation by H. W. Gillett, chemist of the Bureau of Mines, in cooperation with the laboratory of Cornell University, the American Institute of Metals and a number of manufacturers of brass.

Up to the present most brass has been made in costly crucibles of imported clay and graphite. Since the war it has been impossible to obtain the imported materials for crucibles, and manufacturers have had to put up with crucibles of much poorer quality, and at a cost many times that of prewar prices. With the huge tonnage of brass needed for war purposes, such as shells for cartridges, manufacturers have been anxious for a solution of the crucible problem. The bureau states it is inevitable that the next few years will see electric furnaces largely replacing crucible furnaces and that there will be a development comparable to that seen in the steel industry in the last few years. The electric furnace, it is also declared, will greatly decrease the loss of zinc which, together with copper, makes brass. Zinc boils at a much lower temperature than copper, and there have consequently been large losses in the open crucible furnace through volatiliza-

(*Concluded on page 274*)

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors. Synthetic Medicinals, Flavors and Perfumes. Explosives, Photographic Developers.

Edited by
THOMAS H. NORTON, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

George H. Bruce, LL.B., Keystone Fibre Products Co., Inc., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hebden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles

H. Gardner McKerrow, of E. F. Drew & Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

China as a Market for American Coal-Tar Colors

Throughout the world there has been, for several years past, a general recognition of the enormous possibilities of China as a market for a great variety of American and European manufactured products, as the country is opened to commerce and its consumptive power expands.

The German dyestuff trade was prompt to recognize these possibilities and had organized a very extensive distribution of its products prior to the war. In fact, China consumed about two-thirds of the artificial indigo exported from Germany.

Now China is turning to the United States for its supply of dyestuffs, and American color manufacturers are studying the peculiarities of Chinese trade. Sales of certain dyes have already reached respectable figures.

The following study by our consul-general of Hongkong furnishes an excellent picture of the Chinese trade in dyeing materials and how a market may be obtained for the American products:

There is no prejudice against American dyes. Most firms now in the business are British, and usually they prefer to handle British products. At the present time, however, British products in many lines are not to be had, and in any event, American dyes are as acceptable and popular as any other unknown dyes—and practically all of the dyes on the market at the present time are unknown compared with the German products imported before the war. An American representative of an American dye concern working in this market has sold well toward half a million dollars' worth of American dyes and, until competition from Europe comes, will doubtless sell more.| The trade here is reaching out for such products, and under normal conditions American-made dyes, when of proper quality, will have as good a chance in this field as any other dyes.

American manufacturers, however, have so far not been disposed or able to meet the terms under which Chinese users of dyes are accustomed to buy their materials, and the indications are that only by a complete grasp of the situation, viewed on a large scale, will American exporters permanently succeed in the business. The trade is so large and the American manufacturer's opportunity is so exceptional at this time that it is folly to consider the trade upon any other than a permanant basis. The fact is that the dye trade in the Far East (as measured by that of South China, at least), is one requiring large capital, thorough organization, and patient use of the highest merchandising ability.

Complete and definite figures as to the volume of the trade in Hongkong and South China are not to be had, for no Hongkong returns are available and a considerable portion of the trade was carried on with districts other than those included in the Chinese customs returns. Figures obtained from commercial sources place the quantity of aniline dyes sold in the Hongkong field in 1911 at 12,850,000 ounces, valued at about $225,000 Hongkong currency; in 1912, 14,500,000 ounces, valued at $433,000; and in 1913, 18,800,000 ounces, valued at $540,000 Hongkong currency. The sales of synthetic indigo in 1911 amounted to about 9,000 piculs (picul=133 1/3 pounds), valued at about $485,000 Hongkong currency; in 1912, to 8,860 piculs, valued at about $449,000, and in 1913, to 21,400 piculs, valued at about $1,128,000. These three years were the last years of normal trade. (The U. S. Treasury exchange value for the Hongkong dollar was about $0.42 in 1911; from $0.43 to $0.49 in 1912, and from $0.47 to $0.50 in 1913.)

In a general way, therefore, it may be said that the annual value of this trade in the Hongkong field is around a million dollars gold in normal years.

For all China the trade in aniline dyes and artificial indigo in 1913 reached $3,961,962 and $7,038,237 gold, respectively, or a total of $11,000,199. These imports were credited almost entirely to Germany and Belgium. The trade in fact was German trade.

The secret of German success lay as much in the German plan of merchandising as in scientific and economical methods of manufacture. There were several primary arrangements upon which all the German factories based their trade. One was the maintenance of large stocks of dyes on the spot—not only in large centers like Hongkong and Shanghai, but in all the principal cities and dye centers of China as well. A second was a system of sales on commission, i. e., the factory carried the stocks and risks, tided over all fluctuations in prices, bad seasons, and the like. Another was financial aid to dyeing establishments such as the large dye establishments the Chinese maintain in various centers for dyeing goods on a large scale. Still another was a graduated system of rebates on sales granted all agents in the shape of bonuses on quantities consumed; and, lastly, a general system of propaganda work, including not only advertising but the service of trained dyers and demonstrators and the like. This whole system was carried on by the factory, by the exporter. The dealer in Hongkong was in reality only an agent selling on commission.

The crux of the entire system was the maintenance of large stocks on hand—an arrangement that meant the locking up of considerable capital. How large the stocks of these dyes kept in China have been may be deduced from the fact that when the war in Europe broke out and the import of dyes from Germany ceased China at once began to re-export the stocks of dyes on hand.

In 1914, China imported aniline dyes to the value of $2,225,121 gold and re-exported them to the value of $24,188. In 1915, China imported aniline dyes to the value of $291,960 and re-exported them to the value of $1,759,737. In 1916, the imports were valued at $387,390 gold and the re-exports at $1,690,840. Imports of artificial indigo in 1914 were valued at $6,955,758 gold and re-exports at $16,551. In 1915, the imports were valued at $2,568,261 and the re-exports at $3,958,762 in gold. In 1916, the imports were valued at $340,821 gold and the re-exports at $374,969 gold.

Accordingly, there must have been on hand in China at the beginning of the war enough of a stock of aniline dyes and synthetic indigo to enable China to supply its own wants since that time (upon a restricted scale, of course), and export surplus stock to the value of over $4,000,000 gold, to which the stock on hand in Hongkong at the time should be added.

Most American manufacturers would be disposed to bear, or at least share, the burden of advertising and propaganda where contracts of purchase were such that they could receive the benefit of this advertising. Such benefit, however, hinges upon the establishing of recognized brands of dyes and upon a continuous and systematic sales system; for advertising without complete merchandising details usually is lost. A sales system in turn involves the use of trained men, not only salesmen from the United States or the factory generally, but Chinese salesman and experts trained in the use and sale of the products of a particular factory. Such an organization (assuming it is not possible to secure one ready made) represents years of efforts and expenditure. In this the Hongkong or Chinese importer can not bear the burden alone. Even if he is willing to advance the capital and brains to do the work, he can only do it under contracts protecting his work.

The fact is, in such lines as dyes and in such a field as China, this work is primarily the business of the manufacturer. After a manufacturer has established his goods here under his own "chops" or trade-marks, he can sell in the open market, as American exporters generally wish to sell at the present time. He can not do so in a permanent trade, however, until his goods are recognized. With the competition he will face after the war, the maker of dyes not known by a recognized "chop" will have no chance.

The Toluene Supply

A most important factor in connection with our vigorous prosecution of the war is the available supply of toluene to use in the manufacture of trinitro-toluene for high-explosive shells. The War Department estimates its needs for 1918 at 22,000,000 gallons, giving this figure as a minimum. The total annual production of toluene from American coke plants did not exceed 11,000,000 gallons in 1917. It has been necessary to plan on a large scale for "stripping" the aromatic hydrocarbons from ordinary illuminating gas, separating the toluene from the resultant mixture of benzene, toluene and xylene, and placing it at the service of the War Department. It is hoped, by this means, to secure most of the additional quantity required.

There are several important questions involved in the execution of this plan.

In the first place a recovery plant is a somewhat costly construction. Its usefulness would cease with the return to normal conditions. Gas companies hesitate to invest $300,000 or more in such an installation. This difficulty has been overcome by the readiness of the Government to assume any loss which may result from this score.

A much more complicated question is that connected with the basis for estimating the value of gas to consumers. The removal of the light oils from gas deprives it of its chief source of luminous power, but does not so seriously affect its thermal power. About 80 per cent. of the gas produced in our great cities is already used for heating purposes. The proposed changes would mean that the remaining 20 per cent should be utilized with incandescent mantles as a source of illumination. This involves further a change from the standard of candle power (ordinarily 22 candle power) to the standard British thermal units.

Discussion has centered upon the exact thermal standard which should be adopted as the equivalent of the heating power of the gas now currently produced, prices of gas to consumers remaining unchanged. In New York City the Public Service Commission has fixed 650 B. T. U. as a standard, while the gas companies urge a reduction to 585 B. T. U. In St. Louis the companies request a reduction from 600 to 575 B. T. U.

The question at issue is very clearly treated in the following statement by the Chairman of the New York Public Service Commission:

"The Commission upon its own resolution was holding a hearing to determine the advisability of changing the present candle power standard to the British thermal unit standard for the measurement of gas. The testimony adduced from the leading experts upon the subject had established the superiority of the British thermal unit standard, both scientifically and practically. While these hearings were in progress the Commission received a direct appeal from General Crozier, Chief of the Ordnance Department of the United States Army, setting forth the necessity that confronted the army in its need for toluol. Within twenty-four hours after a conference with General Crozier's representatives the Public Service Commission, on October 13, entered the order which will give freedom to the gas companies to change their standard of measurement so as to make practical the extraction of toluol. In my opinion, which was concurred in by all my fellow-Commissioners, it is stated:

"'A national emergency now confronts the Commission, which makes it imperative that, in the exercise of powers conferred upon the Commission, it take action more immediate than was originally contemplated to coordinate the industry of manufacturing and supplying gas in the City of New York to paramount national needs. Any delay in the action necessary to place the companies in a position to meet the requisition of the Government for a certain by-product of gas which can be recovered in sufficient quantity only if gas be manufactured under a thermal standard would jeopardize national interests. The Federal Government has made direct representations to the Commission that it is urgently necessary that the operations of the principal gas plants in this city and elsewhere be made available for the production of an important ingredient essential to war operations. To accomplish this it becomes necessary for the period of war to permit the gas companies to exercise the option of furnishing gas on a thermal basis.'

"The gas department of the Commission had made extensive tests, covering a period of eight months, to determine as nearly as it was scientifically ascertainable the thermal units of gas now furnished consumers under the present twenty-two candle power standard, as fixed by law. These tests and the testimony of experts led the Commission to fix 650 thermal units as that equivalent. The order of the Commission provided that if the thermal content of the gas is reduced below this equivalent by reason of the extraction of the by-product to meet the needs of the Government the price of the gas furnished to consumers shall be reduced by a discount in proportion to the decreased thermal conten. In other words, the consumer will pay for his gas at the same rate that he does today; if his gas should be reduced in quality, the price he pays will be correspondingly reduced.

"There can be no loss to the company by reason of this reduction, as the representatives of General Crozier assured me that the Government is prepared to make good any loss to the company, should there be any, and to pay for the installation of the necessary plants.

"The Commission by its decision, promptly meeting the needs of the Government, has conserved the interests of the consumers as well as those of the gas companies, who are free to complete their arrangements with the Government in the supply of toluol. OSCAR S. STRAUS,

"Chairman Public Service Commission."

Gradually the parties interested in the different centers of population, the representatives of the consumers of gas and of the producers of gas, are coming together in the patriotic effort to ensure the needed supply of toluene at the earliest date possible, and before long the gas of our cities will surrender its entire toluene content and be on a purely thermal basis—undoubtedly to the satisfaction of the manufacturers of incandescent mantles.

There is an interesting question in this connection which does not seem to have been raised, and that is as to the desirability of returning to the gas the benzene and the xylene stripped from it, along with toluene, after the latter has been separated by distillation. Such treatment would do much to raise the thermal value and bring it back nearly to its primary figure. A carburetting of this nature or by some analogous means, might be attempted to obviate any practical disadvantages resultant from the towering of thermal power in consequence of stripping.

It had been hoped that the Rittman process for making benzene and toluene from petroleum residues might be sufficiently advanced so as to contribute, to some extent, in meeting this emergency.

Unfortunately that is not the case. We must depend for the present on the production of our coke plants and our gas works.

T. H. N.

Poisoning from Trinitro-Toluene

The manufacture of trinitro-toluene in this country, for use in shells, has already assumed vast dimensions and will prospectively be doubled at an early date. There has been constant evidence of more or less poisoning among those engaged in making or handling the product. The "Journal of the American Medical Association" contained recently a study on the subject, in which the nature of the toxic action is carefully analyzed. It appears to stand in a direct relation to the extent of free ventilation in the factories where manufacture is carried on. Fumes are liberated by tinitro-toluene at as low a temperature as 32° C. (90° F.). If the circulation of air is defective symptoms of poisoning multiply. They lessen and practically disappear if thorough ventilation is maintained. This would lead to the assumption that the physiological action follows an inhalation of nitrous fumes. The recent investigations of Moore point, however, to the conclusion that the poisoning is caused by absorption through the skin of the compound itself. An oily condition of the hands seems to favor the absorption.

Personal susceptibility has some influence in determining the incidence of symptoms, and whether they appear after a short or after a considerable period of work. This is well shown in the case of dermatitis. But the amount of the exposure, or in other words, the dose of the poison, is the more important factor in producing the toxic effects.

The manufacture of trinitro-toluene in this country is mainly confined to a few firms, so that effective supervision can be planned. The loading of shells, on the other hand, is likely to be carried on by any manufacturer possessing the requisite facilities, which are comparatively simple.

In a paper on the safe handling of trinitro-toluene, read before the Section on Industrial Hygiene of the American Public Health Service, Surgeon Schereschewsky of the U. S. Public Health Service pointed out that the number of workers involved in loading operations is likely to be much greater than that concerned in the manufacture of this substance. Long contact with the production of other poisonous nitrated benzene products should have given manufacturers of trinitro-toluene the requisite experience to enable them to handle the manufacture of this substance with safety to the workers concerned. In addition to this, in the manufacture of trinitro-toluene, except at the final sieving and packing operations, the substance is handled either in closed containers or in a moist condition, under which circumstances the risk of poisoning is greatly reduced.

In loading operations, on the other hand, there is constant opportunity for nearly everyone connected with such work to become the subject of chronic poisoning through either the fumes or the dust of this substance. Valuable practicable points have been outlined by Schereschewsky in a recent number of Public Health Reports which should be in the hands of everyone interested.

The Distillation Products of American Lignite

There has been an increased amount of attention devoted during the past two years to the possibilities of American lignites. The great belt of lignite, occurring in Central Germany, has been exploited for many years. No less than 12 factories, employing over 1,200 workmen, are occupied with the systematic distillation of the lignite from these deposits and the recovery of the by-products. The residual coke is unfitted for metallurgical purposes, but serves admirably for the production of briquettes.

American chemists have felt that the time has arrived for utilizing the vast amounts of lignite found in our far western States, and making them as valuable national assets as is the case in Germany.

A plant was established in 1915, near Denver, with a daily capacity of 500 tons, and has been operating successfully upon Colorado lignite.

Professors H. K. Benson and L. L. Davis of the University of Washington have recently published in the *Journal of Industrial and Engineering Chemistry* (Vol. 9, p. 946) the results of a careful study of the distillation of a representative Washington lignite.

A series of comparative experiments showed that a temperature of 380° C. was the most favorable for the production of tar. At this temperature one ton of lignite yields 108 pounds of tar, or about 5.5 per cent. This tar shows a great similarity to petroleum or shale oil and has but little in common with ordinary coal tar. There is an entire absence of benzene and its homologues. One-third of the tar is soluble in alkalis. The solution thus obtained is free from phenol, although containing cresols and higher homologues.

The oils, obtained by the distillation of the tar, belong chiefly to the paraffin series, and can be used as solvents, lubricants, for motor fuel, etc. Seven pounds of paraffin wax are yielded by one ton of lignite.

The gas evolved is relatively small in amount at 380°, and low in thermal value. The yield of ammonia is about 4 pounds per ton at this temperature. The residual coke is 54 per cent. of the weight of lignite.

Distillation at higher temperatures increases the quantity of gas and ammonia, while lowering the yields of tar and coke.

The results of this preliminary work show that our western lignites cannot be expected to play any pronounced rôle in supplying the crude materials formed by the distillation of bituminous coal. Undoubtedly their complete utilization by distillation and collection of the by-products is most desirable. Our sources of combined nitrogen and of motor fuel will be materially augmented, while the value of a large supply of cheap gaseous and briquette fuel will count for much in the industrial expansion of the West.

The Manufacture of Dimethylaniline and of Diphenylamine

Among the derivatives of aniline employed in the manufacture of colors dimethyl-aniline and diphenylamine stand in the forefront. A recent issue of "The Dyer and Calico Printer" contains a valuable study by Dr. E. Grandmougin on the current French practice in the production of the two intermediates, from which we quote the following:

Dimethylaniline.

Dimethylaniline was discovered in 1861 by the French chemist, Bardy, and prepared on a commercial scale for the first time in the Porrier works at St. Denis. The inventor's process is still used, the alkylation of aniline in the presence of a mineral acid. The only variation that has been made is that it has been found advantageous to replace the hydrochloric acid originally used by sulfuric acid. The reaction which takes place can be explained in different ways. Nevertheless, it seems almost certain that, to begin with, methyl chloride or methyl sulphate is formed, which, reacting on the aniline, produces, first, methylaniline and then dimethylaniline.

On the other hand, the action of sulfuric acid in methyl alcohol generates methyl ether, which is gaseous at the ordinary temperature and produces a considerable pressure. In order to attain the temperature necessary for the reaction, the process is effected in autoclaves, and this requires special precaution.

Formerly the autoclaves were constructed of cast iron. Now they are made preferably of steel, and to avoid the attack of the acid they are lined with enamel, or a special metal resisting acid. The space between the lining and the autoclave is filled with melted lead.

Each autoclave is of 300-litre capacity, and is charged with 80 kilos of aniline, 78 kilos of methyl alcohol, and 8 kilos of sulfuric acid at 66° Bé. The night before the work is to be done, the sulfuric acid and methyl alcohol are mixed in two portions. Two carboys are charged with 39 kilos of methyl alcohol each and 4 kilos of sulfuric acid are slowly poured in to each carboy.

The morning of the operation, the autoclave is charged by pouring in, to begin with, half of the aniline, that is, 40 kilos, then adding the methly alcohol and sulfuric acid already mixed as described, and then the second 40 kilos of the aniline. The autoclaves are charged and ready for work by about ten in the morning, then are heated up gradually to a temperature of 230° to 235° C. The pressure rises at the same time. At about two in the afternoon it has attained 30 kilos (67 lbs.), and is kept at this throughout the operation. About eleven in the evening the heat is shut off, and the autoclave is allowed to cool until the next day.

When the temperature has become normal, the pressure is released by allowing the gases to pass into a condenser to recover the methyl alcohol. Then by means of compressed air the contents of the autoclave are passed into a still. The amount passed in is regulated by the size of the still, and the autoclave may be emptied in successive portions—six, for instance.

Caustic soda has already been introduced into the still to liberate the dimethyl-aniline, which is in the form of sulphate. Steam is then introduced into the still, the methyl alcohol passes over first and is condensed apart. Then dimethyl-aniline passes over with the water, which is collected in a separator. After separation from the water, it is stocked in iron drums. There is no necessity ordinarily to redistill it. If for some reason this has to be done, it is distilled in the same manner as aniline, preferably in a vacuum.

On an average the yield is 98 kilos for the proportions indicated. Although to carry over the dimethylaniline six parts of steam suffice, theoretically, for one part of the base, practically at least three times as much steam is necessary, and this must be taken into account in calculating the cost.

In the pure state dimethyl-aniline distils at 102° C. The specific gravity is 96 at 15° C.

The purity of dimethyl-aniline is controlled by distillation. It should pass over between 191° and 193° C. to detect the presence of methyl-aniline, it is tested with acetic anhydride. There should be no rise of temperature when 10 c.c. of dimethyl-aniline and 3 c.c. of acetic anhydride are mixed at the same temperature.

The aniline used in the manufactur should be very pure, and should not contain more than ½ per cent. of water. Its specific gravity should be from 1.026 to 1.027 at 15° C. It should distill between 182.4° and 182.8° C.

The methyl alcohol employed must be free from acetone, which would lead to exaggerated pressure. The following calculation is valuable merely as an estimate giving the approximate cost of the manufacture of dimethyl-aniline before the war: 80 kilos aniline, 80. 00 fr.; 78 kilos methyl alcohol, 90.00 fr.; 8 kilos sulfuric acid, 0.50 fr.; 8 kilos caustic soda, 2.10 fr.: 1,800 kilos steam, 5·40 fr. 100 kilos of dimethyl-aniline would cost 178.00 fr. or $15.00 per 100 lbs.

Dimethyl-aniline was sold at 200 francs per 100 kilos before the war.

Dimethyl-aniline can also be made with methyl chloride, which is a by-product in sugar making. As this can be obtained by the action of chlorine on methyl alcohol, it might be an advantageous process after the war in order to use up the chlorine, of which there will be heavy stocks. The method is worked at St. Denis, by Vve. Brigonnet et Fils.

An autoclave with a double jacket is fitted with an agitator capable of making 125 to 130 turns per minute. This is charged with 50 kilos of aniline and 40 kilos of quick lime, slaked to 75 litres, and heated to 100° C. Then 62 kilos of methyl chloride are introduced gradually, taking two hours in making this addition. The pressure is maintained at 5 to 6 atmospheres.

At the close the pressure is lowered to 2½ atmospheres, and the contents of the autoclave are passed into a still by means of compressed air. In this the dimethyl-aniline is distilled over by means of steam. The yield is 116 to 120 per cent. of the weight of aniline. The operation is very rapid, and the autoclave may easily be charged twice in one day.

The uses of dimethyl-aniline are very numerous. Notably it serves as material for the manufacture of Methyl Violet, Malachite Green, Meldola's Blue, Methylene Blue, and other basic colors.

Other Methyl and Ethyl Derivatives.

Methyl-aniline is prepared in the same manner as dimethyl-aniline, but with a smaller proportion of methyl alcohol. For 100 kilos of aniline salt, 32 kilos of methyl alcohol are used, and the mixture is kept at 180° C. for ten hours. At the termination of the reaction, the product is made alkaline by means of lime, and the methyl-aniline is distilled with steam in the manner already described.

The product obtained contains about 90 per cent. of methyl-aniline. The balance is 6 to 7 per cent. of dimethyl-aniline and a little unchanged aniline.

Pure methyl-aniline is a colorless liquid, boiling at 192° C., and has a specific gravity of ·976·at 15° C. By acylation it gives methyl-acetanilide (exalgine), melting at 102° C.

Replacing the methyl alcohol by ethyl alcohol, ethyl-aniline and diethyl-aniline can be prepared. It must be noted, however, that in preparing diethyl-aniline with sulfuric acid, aniline hydrochloride must be used.

Ethyl-aniline boils at 204° C., and has a specific gravity of .94 at 18° C. Diethyl-aniline distils at 213.5° C., and its specific gravity is .936 at 18° C.

Diphenylamine.

To prepare this base, and other aromatic secondary amines, the process invented by Girard and de Laire is used. This depends upon the action of the salts of the amine on the amine according to the following quation:

R = pehenyl, etc, $R.NH_2 + R.NH_2HCl = R.NH.R + NH_4Cl$

This process is applicable homologues and mixed derivatives. Phenols may also be used:

$$R.OH + R.NH_2 = R.NH.R + H_2O$$

This reaction is not employed in the case of diphenylamine. It serves, for instance, for the preparation of diphenylmetaphenylenediamine, with resorcin and aniline, and of phenylnaphthylamines with naphthols and aniline, and of similar products. All these reactions are effected at a high temperature and under pressure.

The extensive use of the derivatives of diphenylamine has brought about a new method of synthesis at a lower temperature. They are often prepared also by reduction of the corresponding indamines and indophenols which are themselves produced by the oxidation of paraphenylenediamines. The indophenols can also be synthesised by condensation of the nitrosophenols with the amines in the presence of sulfuric acid. This process is simply a variation of the one already mentioned.

As already stated, diphenylamine is prepared still by Girard and de Laire's process. The operation is carried out in an autoclave which is lined with enamelled metal unattackable by acids, or the autoclave may be of earthenware, which is heated preferably, not in an oil bath but in a bath of an alloy,—30 per cent. tin and 70 per cent. lead, for instance.

As an example, 70 kilos of aniline salt and 50 kilos of aniline are heated to 260° C. This temperature is maintained for twelve hours, then the contents of the autoclave are allowed to cool. The operation is controlled by noting the pressure indicated by the manometer,—about 3 to 4 kilos. The complete operation takes 24 hours.

It is essential to use an anhydrous aniline salt and aniline free from water. It is evident that aniline and hydrochloric acid may be mixed in the desired proportion, distilled in a vacuum and dried; then the necessary proportion of aniline is added and the mixture is poured into the autoclave. Aniline salt is soluble in warm aniline.

The operation completed, the mixture is poured into a vat and boiled with hydrochloric acid in order to remove the aniline in excess. The cake of melted diphenylamine is then treated with boiling water, next with dilute soda, and again with boiling water. The operation is terminated by distilling the diphenylamine, preferably with the use of a vacuum. Water and a little aniline pass over at first, then diphenylamine. A little tar remains in the retort. Another way is simply to pour the mixture into water to remove the aniline salts and the ammonium chloride, following this by separating the aniline from the diphenylamine by fractional distillation. The yield may reach 80 percent. The untransformed aniline is recovered and used again. An important amount of the ammonia formed can also be recovered.

Commercial diphenylamine is usually sent out in compact yellowish blocks with a characteristic odor. It is fusible at 54° C., and distills at 310° C. To obtain it in a crystalline state, it is crystallized from alcohol or acetic acid forming white crystals.

The following calculation of pre-war prices allows an idea to be formed of the cost of production:

70 kilos aniline salt, 65.00 fr.; 50 kilos aniline, 50.00 fr.; 70 kilos diphenylamine, 116·fr.

This makes 165 francs per 100 kilos of diphenylamine for material alone, or $14.50 per 100 lbs.

(*Concluded on page 274*)

INORGANIC CHEMICAL SYNONYMS

A Novel Work of Reference for Student and Chemist

By

ELTON R. DARLING*

Although Intended Primarily for the Student, It Is Believed that the Following Compilation of the Various Terms Employed to Designate Inorganic Chemicals Used in the Industries Will Prove a Convenience to the Experienced Chemist. The Writer Claims No Originality for the Synonyms, but Only the Bibliographical Research of the Material at Hand. The list will be completed in the next issue.

PART V

Nickel, 58.68.

It has a specific gravity of 8.7. It has a melting point of 1,450° C. It has a valency of two in the nickelous condition, and four in the nickelic condition.

Our first knowledge of nickel is found in the writing of Hiarni, who in 1694 speaks of it as "false copper." It was so called because although, possessing the color of copper ore, the metal could not, however, be separated from it. In 1751 Cronstedt published an investigation on an ore from the Helsingland mines. He obtained a salt which gave a green vitriol and a hard brittle metal. In 1754 he wrote of it as a semi-metal and called it nickel.

His views were not accepted until 1774, when Bergman's researches confirmed his work.

- Nickel Oxide, 74.68
  - *Nickelous Oxide*
  - *Protoxide of Nickel*
  - *Nickel Black*
- Nickel Sulfate, 262.85
  - *Electrolytic Salts*
  - *Blue Salts*
- Nickel Sulfide, 90.75
  - *Black Sulfide of Nickel*
  - *Capillary Pyrites.*

Potassium, 39.10.

Melts at 62.5° C. and boils at 757.5° C. It has a specific gravity of .875 and a valency of one.

The discovery of potassium was made by Davy in 1807. It was obtained from potash by electrolysis.

- Potassium Bicarbonate, 100.11
  - *Potassii Bicarbonas*
  - *Acid Carbonate of Potash*
  - *Sesqui-carbonate of Potash.*
- Potassium Carbonate, 174.23
  - *Potassii Carbonas*
  - *Kali Praeparatum*
  - *Fixed Nitre*
  - *Pearl Ash*
  - *Pearl Ashes*
  - *Salt of Tartar*
  - *Salt of Wormwood.*
- Potassium Chloride, 122.56
  - *Potassii Chloras*
  - *Oxymuriate of Potash.*
- Potassium Chloride, 74.56
  - *Bitter Salts*
  - *Febrifuge Salt*
  - *Digestive Salt of Sylvius.*
- Potassium Ferricyanide, 329.20
  - *Red Prussiate of Potash*
  - *Potassae Prussias Rubra*
- Potassium Ferrocyanide, 422.35
  - *Potassii Ferrocyanidum*
  - *Potassae Prussias Flava*
  - *Yellow Prussiate of Potash*
- Potassium Hydroxide, 56.11
  - *Potassa*
  - *Potassae Hydras*
  - *Hydrate of Potash*
  - *Caustic Potash*
- Potassium Acetate, 98.12.
  - *Potassii Acetas*
  - *Diuretic Salts*
  - *Sal Diureticus.*
- Potassium Bisulfate, 136.18
  - *Potassae Supersulfas*
  - *Supersulfate of Potash*
  - *Acid Potassium Sulfate*
- Potassium Nitrate, 101.11
  - *Potassii Nitras*
  - *Saltpetre*
  - *Nitre*
  - *Sal Prunella*
- Potassium Sulfide, 110.27
  - *Potassa Sulfurata*
  - *Potassii Sulfuratum*
  - *Hepar Sulfur*
  - *Liver of Sulfur*
- Potassium Bitartrate, 188.14
  - *Potassii Bitartras*
  - *Potassae Supertartras*
  - *Acid Potassium Tartrate*
  - *Tartar*
  - *Cream of Tartar*
  - *Cremor Tartari*
  - *Supertartrate of Potash*
- Potassium and Sodium Tartrate, 280.18.
  - *Potassii et Sodii Tartras*
  - *Tartrated Soda*
  - *Rochelle Salt*
  - *Sal Seignette*

---

*All rights of publication in book form reserved by the author. Research Textile Chemist, 251 Clifton Place, Brooklyn, N. Y.

Silver, 107.88.

Silver has a melting point of 955° C. and a boiling point of 1,955° C. Its valency is one.

Silver is another of those elements whose history must remain a romance. The alchemists spoke of it as "Luna" or "Diana" and represented it by the symbol of the crescent moon.

Silver Chloride, 143.34
  Argenti Chloridum
  Butter of Silver
  Horn Silver
  Muriate of Silver
Silver Nitrate, 169.89
  Argenti Nitras
  Lapis Caustic
  Luna Caustic
Silver Sulfide, 247.83
  Argenti Sulfidum
  Silver Glance

Sodium, 23.00.

It has a specific gravity of 0.9735. It melts at 97.3° C. and boils at 877.5° C. The valency is one.

It is to the Old Testament that we turn for our history of the sodium compounds. There reference is made to sodium carbonate, although it was then called "Nether." In Egypt it was called "Flos Satis." Down through the ages the salts of sodium were common, and much use was made of them. It was not, however, until 1807 that Davy prepared the metallic Sodium.

Sodium Bicarbonate, 84.01
  Sodii Bicarbonas
  Acid Carbonate of Soda
  Hydrosodic Carbonate
  Sesquicarbonate of Soda
  Vichy Salts
Sodium Carbonate, 106.00
  Sodii Carbonas
  Crystal Carbonate
  Fixed Mineral Alkali
  Natron
  Natrum
  Scotch Soda
  Soda Crystals
  Trona
  Washing Soda
Sodium Chloride, 58.46
  Sodii Chloridum
  Common Salt
  Muriate of Soda
  Sal Communis
  Sal Culinaris
  Salt
  Table Salt
Sodium Hydroxide, 40.01
  Sodii Hydras
  Caustic
  Caustic Soda
  Soda
  Sodium Hydrate
Sodium Nitrate, 85.01.
  Sodii Nitras
  Chili Saltpetre
  Cubic Nitre
  Nitrate of Soda
Sodium Nitrite, 69.01
  Sodii Nitris
  Diazotizing Salts
Sodium Phosfate, 138.07
  Sodii Phosfas
  Sodium Orthophosfate
  Tasteless Purging Salt
  Tasteless Salts
Sodium Sulfate, 268.18
  Sodii Sulfas
  Natron Vitrolate
  Glauber's Salt
  Sal Glauberi
  Salt Cake
Sodium Silicate, 303.20
  Sodium Tetrasilicate
  Silicate of Soda
  Soluble Glass
  Water Glass
Sodium Thiosulfate, 248.22
  Sodii Thiosulfas
  Antichlor
  Hypo
  Hyposulfite of Soda

(To be concluded)

Technical Men Unite for War Work

Representing an effort to cooperate effectively and vigorously for war work, an important joint war committee has been formed by representatives of technical societies centered in Chicago. The movement was started by the Military Committee of the Western Society of Engineers, and, at the invitation of that committee, several meetings have been held at the Chicago Engineers' Club. As the result, the "War Committee, Technical Societies of Chicago," to quote the official name, was organized June 4, 1918.

The purpose of this organization is "to enable the technical societies of the Chicago zone to call into play the efforts of the members of the various societies herein represented as occasion may arise, and to coordinate their activities in the most effectual manner to help win the war." It is not proposed to attempt any novel "stunts" but rather to place at the disposal of the United States Government, and other authorized agencies, the combined strength and resources of the Chicago technical societies for war work, as need may arise.

The following member societies are cooperating in the new War Committee:

Western Society of Engineers.
Structural Engineers' Association of Illinois.
Society of Industrial Engineers.

(Concluded on page 274)

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By CARLETON ELLIS and A. A. WELLS.*

PART XIV

Stability Test for Smokeless Powder.

Exposure to ultra violet light considerably accelerates the spontaneous decomposition of smokeless explosives, and this can be made the basis of a useful stability test. Explosives which were examined in this manner by *Berthelot* and *Guadechon* (Compt. rend., 1911, 153, 1220) were cut into cylinders weighing 0.25-0.45 gram, placed over mercury in a quartz tube, containing nitrogen or carbon dioxide, and exposed to the radiation from a quartz mercury lamp at a distance of 78-80 mm. for 6 hours. In all cases rapid decomposition occurred with production of carbon monoxide or dioxide, nitrogen, and frequently nitrous and nitric oxides. Powders consisting only of nitrated cellulose were found to be more stable than those containing nitro-glycerine. An English cordite containing 30% of the latter and 5% of vaseline, exposed in 1 c.c. of carbon dioxide, gave a mixture composed of the following volumes of gases: CO_2, 1 c.c.; CO, 0.17 c.c.; NO, 0.10 c.c.; N_2O, 0.02 c.c; N_2, 0.10 c.c. Numerical results are also given for the French A and B powders and for balistite of different ages and with different stabilisers. (See also Compt. rend. 1912, 152, 514).

Formaldehyde.

According to *Berthelot* and *Gaudechon* (Compt. rend., 1912, 154, 1803) a concentrated aqueous solution of formaldehyde is decomposed by the light from a quartz mercury lamp, even when the rays of wavelength less than 0.19 μ are cut off. The products of decomposition consist of a mixture in almost equal volumes of carbon monoxide and hydrogen, together with some (10%) methane and carbon dioxide. Sunlight also slowly brings about the same decomposition. Formaldehyde cannot be synthesised from a mixture of carbon monoxide and hydrogen by the action of sunlight, even in the presence of catalysts, such as spongy platinum, although it is formed to some extent when the mixture is exposed to the ultra violet rays from a quartz-mercury lamp. In the photochemical reaction, $CO + H_2 \quad CH_2O$, the equilibrium point is more markedly on the side of the decomposition products than it is in the case of the reactions $2H_2O \quad 2H_2 + O_2$ and $2CO_2 \quad 2CO + O_2$.

Higher Aldehydes.

When formaldehyde solutions are exposed to the radiation from a quartz-mercury lamp, according to *Pollitzer* (Monatsh., 1913, 34, 797) they undergo partial decomposition into carbon monoxide, carbon dioxide, hydrogen and methane, and partial polymerisation to glycolaldehyde and higher products. The higher aldehydes have been observed to form carbon monoxide, hydrogen, and the hydrocarbon corresponding with the radical to which the aldehyde group was previously attached. A re-investigation of the behavior of the homologues of formaldehyde indicates that they decompose mainly according to the equation $R.CHO = RH + CO$; at the same time condensation takes place to some extent accompanied by polymerisation to resinous substances; no pure condensation product could be isolated. Under the conditions of the experiments, in which moisture and atmospheric oxygen were excluded, no formation of acids or of esters could be detected, so that the earlier suggestion of Primbram and Franke that the formic acid obtained in the illumination of formaldehyde solution is produced by the hydrolysis of previously formed methyl formate is hardly probable. From the behavior of crotonaldehyde, which, like benzaldehyde and cinnamaldehyde, gives practically no liberation of gas, it appears that the decomposition expressed by the above equation is characteristic of the saturated aliphatic aldehydes.

The aldehyde under examination was contained in a quartz flask of approximately 100 c.c. capacity which was filled to the neck, any evolved gas being collected over water or mercury; the mercury lamp was at a distance of 2 to 3 mm. from the flask, but the temperature of the aldehyde never exceeded 50°. The substances examined were heptaldehyde, isobutaldehyde, propaldehyde, acetaldehyde, crotonaldehyde, benzaldehyde, and cinnamaldehyde. Crotonaldehyde gave only the formation of a resinous substance, while the two aromatic aldehydes gave merely red, nonvolatile products. Only a relatively small proportion of each aldehyde underwent conversion, although the illumination ranged from one to ten days in various cases.

Acetaldehyde.

A more detailed study of the photolysis of acetaldehyde has been made by *Berthelot* and *Gaudechon* (Compt. rend., 1913, 156, 233) who state that initial ultra violet rays do not convert the aldehyde into acetic acid in the absence of oxygen. Under the influence of medium and extreme rays oxidation takes place even in the absence of oxygen, a portion of the aldehyde being converted into acetic acid. The amount of acid produced is far greater when the aldehyde is in the form of vapor than when it is liquid. With rays (λ 0.25μ) polymerisation is rapid, both para and meta acetaldehyde being formed. No resinification results from the action of initial ultra violet rays, and it is only slowly produced by the medium and extreme rays. The presence of water checks polymerisation and resinification, but favors acidification, formic acid being formed in this case and in amount almost equal to that of the acetic acid.

---

*All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

Terephthalaldehyde.

Although terephthalaldehyde is very stable in the solid state and in solution in benzene in the dark, *Suida* (Monatsh., 1912, 33, 1173; J. Chem. Soc., 1913, Abs., 104, i, 52) states that its solution undergoes rapid atmospheric oxidation when illuminated by a mercury lamp, and a white crystalline deposit is formed. The deposit consists of terephthalaldehydic acid to the extent of roughly two-thirds, the remainder being terephthalic acid. The solution from which the crystals have separated gives a peroxide reaction with acidified potassium iodide solution. This oxidation of terephthalaldehyde appears not to occur at all if light is excluded, and it is not accelerated by the presence of nitrobenzene, in fact this substance exerts a hindering effect. A comparison with benzaldehyde seems to indicate that, assuming the supply of oxygen by diffusion to be more than sufficient, the oxidation velocity of each aldehyde group in terephthalaldehyde is considerably diminished by the presence of a similar group in the para-position. By interposing solutions of potassium chromate and of quinine sulphate between the solution and the source of light, it is discovered that the effect is mainly due to the ultra violet rays, but that yellow and red light can cause the oxidation to occur, although only very feebly. Spectrographic examination indicates that the effective rays are from 400 to 300 $\mu\mu$.

Nitrobenzaldehyde.

According to *Weigert* and *Kummerer* (Ber. 1913, 46, 1207) the transformation of o-nitrobenzaldehyde into o-nitrosobenzoic acid under the influence of light is independent of air and is a simple case of isomeric reaction. In order to study the process quantitatively, acetone had to be chosen as a solvent, since the acid would be esterified by alcohol, and is only sparingly soluble in other media. The solutions were exposed in glass troughs to the rays from a quartz mercury lamp and protected from heat rays by a tank of running water, and as occasion required, filters of nitrosodimethylaniline in 0.0017% solution, and quinine sulphate in 0.05% solution were interposed to cut off the violet, blue and ultra violet light respectively. Preliminary experiments showed that the same results were obtained under the same conditions, that it was unnecessary to stir the solutions, and that the amount of transformation was practically proportional to the time of illumination. In order to study the influence of the intensity of the light, the lamp was stopped down so as to bring the source of light approximate to a point, and the solutions were placed at such distances that the intensities were in the ratio 4; 2; 1, and then illuminated for periods which varied as 1:2:4. It was found that slightly less transformation had occurred in the most remote vessel, thus showing that the Bunsen-Roscoe law, that the same quantity of light produces the same chemical effects, is not quite admissible. In further experiments on the influence of the initial concentration of the solution, the light was filtered through the quinine sulphate or nitrosodimethylaniline solutions, when, after allowing for the amount of light absorbed by these filters, it was found that the sum of the quantities of o-nitrosobenzoic acid formed was practically equal to the amount produced, under otherwise similar conditions, by unfiltered light. In the case of ultra violet light, the effect is independent of the concentration, but for violet light the speed of transformation is, at first, proportional to the concentration. The order of the reaction therefore changes with the kind of light, so that no simple law can be deduced to express the quantitative course of the reaction. No proportion existed either between the speed of the reaction and the amount of light absorbed by the aldehyde although they increased in the same direction. With mixed light, the chief work is done in dilute solutions by the ultra violet rays, and in concentrated solutions by the violet.

Oxalic Acid.

Various solutions of O.1N strength were exposed at 25° in a quartz flask to a Cooper-Hewitt quartz mercury vapor lamp at 10 cm. distance by *Mathews* and *Dewey* (J. Physikal. Chem., 1913, 17, 211). Under these conditions oxalic acid is very slightly affected but in the presence of uranium nitrate, sulphate or acetate is rapidly oxidized at a linear rate proportional to the uranium concentration. It is deduced that the decomposing action of ultra violet light is dependent on the amount of light photochemically absorbed.

Potassium permanganate and dichromate solutions are very stable towards ultra violet light, but the oxidation of sodium sulphite in contact with air is accelerated by these rays.

Lactic Acid.

According to *Euler* (Arkiv. Kem. Min. Geol., 1911, 4, No. 8, 1-10; J. Chem. Soc. 1912, Abs. 102, ii, 112) the degradation of lactic acid to carbon dioxide and alcohol takes place in pure aqueous solution under the influence of ultra violet radiations. The rate of decomposition of the lactic acid does not depend on the concentration of the acid within the limits studied, 0.25 N to N. The condensation of acetaldehyde to aldol also takes place without a catalyst on exposure to ultra violet light. The bearing of these results on the degradation and synthesis of plant acids is discussed.

Lactic and Tartaric Acids.

The decomposition of lactic and tartaric acids in ultra violet light has been investigated by *Euler* and *Ryd* (Biochem. Zeitsch., 1913, 51, 97-106; J. Chem.

Soc. 1913, Abs., 104, 544). Lactic acid in the presence of the short ultra violet rays undergoes a decomposition, analogous to a fermentation, with evolution of carbon dioxide. This reaction is less influenced by temperature than other photochemical reactions. The rate of evolution of carbon dioxide is not accelerated by the presence of either ferrous or ferric salts, but the latter are reduced. Tartaric acid undergoes similar changes in ultra violet light, with the formation of carbon dioxide and reducing substances. In this case ferric (not *ferrous*) salts increase the rate of gas evolution, being reduced themselves at the same time.

Synthesis of Carbohydrates.

In an investigation of the photochemical snythesis of carbohydrates from carbon dioxide and hydrogen in the absence of chlorophyll, *Stoklasa* and *Zdobnicky* (Biochem. Zeitsch. 1911, 30, 433; Monatsh., 1911, 32, 53) have found that water does not act on carbon dioxide in ultra violet light in the absence of potassium hydroxide, neither formaldehyde nor carbohydrate being formed in this case. If potassium hydroxide is added, however, formaldehyde, but no carbohydrate, is formed. The hydrogen must be in the nascent state for the reaction to take place, and ultra violet light must be present, otherwise formic acid is formed. A sugar is also formed when nascent hydrogen reacts with carbon dioxide in the presence of ultra violet rays. The nature of the carbohydrate has not yet been definitely established. The osazone melts at 196-200°, and is not, therefore, either B-formose or B-acrose.

The work of Stoklasa and Zdobnicky has been criticized by *Bob* (Biochem. Zeitsch. 1911, 31, 358).

Sugars.

Berthelot and *Gaudechon* (Compt. rend. 1912, 155, 1153) divide simple sugars into four classes according to their resistance to light; the keynotes are attached by ultra violet rays (λ 0.30μ), the aldoses by the rays ($\lambda=0.30$ to 0.25μ) the straight chain polyhydric alcohols by rays ($\lambda=0.25$ to 0.20μ) the ring polyhydric alcohols only by the extreme ultra violet rays($\lambda=0.20\mu$). With slow vibrations producing the first stage in the action, the liquid remains neutral, and does not reduce Fehling's solution in the cold. With more rapid vibrations, decomposition increases, the liquid becomes acid, and carbon dioxide can be detected in the gaseous products, the amount of hydrogen evolved increases and the solution begins to reduce Fehling's solution in the cold, and finally methane is liberated. The volumes of carbon monoxide and hydrogen evolved in the first stage always bear a simple ratio to one another. The results of a series of comparative experiments are given, and it is found in the case of the ketones that the solid sugars as well as their aqueous solutions undergo decomposition

Dextrose.

Euler and *Lindberg* (Biochem. Zeitsch., 1912, 39, 410; J. Chem. Soc. 1912, Abs. 102, ii., 407) find that an acid is formed from dextrose by the action of ultra violet light. On further action of the light the acid evolves a gaseous mixture containing 15% carbon dioxide, 40% carbon monoxide and 40% hydrogen. This gas is formed from the primary products of the action of light on the sugar. The scission of lactic acid in pure aqueous solution into alcohol and carbon dioxide which takes place in light is a special case of the evolution of carbon dioxide from vegetable acids. The condensation of acetaldehyde, a process so important in the formation of plant acids, is a light reaction. The rate of change of lactic acid into alcohol and carbon dioxide is, within certain limits, independent of theconcentration.

Dextrose and Galactose.

Variations in the photochemical decomposition of dextrose and galactose according to the wave-length of the radiations have been considered by *Berthelot* and *Gaudechon* (Compt. rend. 1912, 155, 831). Unlike the ketones, the aldoses, dextrose, galactose and mannose are practically unaffected on exposure in aqueous solutions to sunlight. They are, however, decomposed under the influence of medium ultra violet rays ($\lambda=0.30$ to 0.25μ). Carbon monoxide and hydrogen are evolved, and the corresponding alcohol, with one carbon atom less than the sugar used, is formed. As in the case of the ketones, secondary reactions occur when they are exposed to the extreme ultra violet rays, carbon dioxide and methane being evolved. The liquid becomes acid and capable of reducing Fehling's solution and ammoniacal silver nitrate.

Laevulose.

Under the influence of light from a quartz-mercury lamp, laevulose, according to *Bierry, Henri* and *Ranc* (Compt. rend. 1910, *151*, 316), undergoes profound decomposition when in aqueous solution, carbon monoxide, carbon dioxide, formaldehyde and methyl alcohol having been recognized among the products. The reaction proceeds more readily in a vacuum than when air is present. Aldoses do not appear to undergo this degradation. Glycerol and mannitol after exposure to the rays require reducing properties.

Berthelot and *Gaudechon* (Compt. rend., 1913, *156*, 707) use a 10 per cent. aqueous solution of laevulose to give a direct measure of the intensity of ultra violet radiation, the volume of the gas evolved being directly proportional to the time for any given radiation, and inversely proportional to the distance. Further, for dilute solutions (4.5 to 18 grams per litre) the velocity of the reaction is proportional to the concentration, while for strong solutions (720 to 1080 grams per litre) it is constant and independent of the concentration. These facts are best explained on the hypothesis that the velocity of reaction is proportional to the quantity of light absorbed per unit of time.

Sucrose.

Bierry, Henri and *Ranc* (Compt. rend., 1911, *152*, 1629) find the first action on sucrose of the light from a quartz-mercury lamp is to hydrolyse the sugar, and then to effect profound decomposition of the two hexoses, leading ultimately to the formation of formaldehyde and carbon monoxide.

A resumé of the published work on the inversion of sucrose by ultra violet rays and a reply to Bierry, Henri and Ranc is given by *Berthelot* and *Gaudechon* (Compt. rend. 1913, *156*, 468).

A study of the bioses, maltose, lactose, trehalose and gentiobiose, and the trioses, raffinose, melesitose and gentianose, by ultra violet rays of varying wave-lengths has been made by *Berthelot* and *Gaudechon* (Compt. rend. 1912, *155*, 1506). In the case of the trioses no first stage of formation of a monose and a biose could be detected. After the first stage of decomposition, the action was the same as in the case of the monoses.

Soluble Starch.

Massol finds that (Compt. rend., 1911, 152, 902) soluble starch becomes hydrolysed when its aqueous solution is exposed to the light from a quartz mercury lamp. Changes in the rotary power of the solution show that the transformation is probably into dextrins and maltose, although the amount of sugar isolated was insufficient for identification. The hydrolysis is not due to the small amount of hydrogen peroxide formed under the action of the rays.

Quinine Sulphate.

When an aqueous solution of quinine sulphate in contact with air is exposed to the light emitted by a quartz mercury vapor lamp, oxygen is absorbed. *Weigert* (Festschrift W. Nernst, 1912, 464; J. Chem. Soc. 1912, Abs. 102, ii, 1120) has made experiments directed to an explanation of the nature of this reaction. The progress of the change could be readily followed by measurements of the volume of gas absorbed.

The reaction velocity increases with increasing concentration of the quinine sulphate, but is diminished by addition of acid. From experiments with gas mixtures containing variable proportions of oxygen, it is found that the reaction velocity increases continuously as the partial pressure of the oxygen diminishes. For a mixture of oxygen and nitrogen containing 0.6 per cent. of oxygen, the velocity is about thirty times as large as for pure oxygen. The nature of the oxidation process appears to vary, however, with the proportion of oxygen in the gas mixture, for a larger proportion of the absorbed oxygen was found to have been activated when the gas mixture was rich in oxygen. The activated oxygen is only present to a small extent in the form of hydrogen peroxide, the major portion existing in a loosely combined form, which may be removed by a current of carbon dioxide or nitrogen

A similar influence of the oxygen concentration on the reaction velocity has also been observed in the photochemical oxidation of fluorescein and tetraiodofluorescein

Stereoisomerides.

In connection with the stereoisomerides of substituted ethylenes *Stoermer* (Ber., 1909, *42*, 4865; J. Chem. Soc. 1910, Abs. 98, ii, 114) states that the conversion of the labile into the stable modification by the action of light, particularly in the presence of a halogen, is not uncommon. The converse change, produced by light alone, has been remarked in very few cases. Perkin has noted the conversion of methylcoumarinic acid into methylcoumaric acid by sunlight, but Stoermer finds that in the coumaric acid series the tendency is the other way, the stable form changing to the labile under the influence of ultra violet light. Thus Perkin's change occurs only to the extent of 25 per cent., whereas coumaric acid yields 75 per cent. of coumarin, methylcoumaric acid yields 75 per cent. of methylcoumarinic acid, ethylcoumaric acid yields ethylcoumarinic acid quantitatively, and acetylcoumaric acid is also quantitatively changed to acetylcoumarinic acid. That the changes are caused by the ultra violet rays is proved by means of light filters, the interposition of a filter which absorbs ultra violet light between the lamp and the solution preventing any change of the stable to the labile modification. Hence the less fusible stable forms of stereoisomeric compounds can be changed directly, under definite conditions, into the more reactive labile modifications if energy is supplied by ultra violet light. Thus the stable form of o-anisylcinnamic acid, which could not be changed into the labile modification by Stoermer and Frederici has been converted to the extent of 50 per cent. by using a more intense light. In the case of stereoisomeric a-alkylated acids, the conversion of the stable into the labile form is a matter of great difficulty. The case of cinnamic acid is interesting. A benzene solution of ordinary cinnamic acid was exposed for eight days to the light of a Uviol lamp, with the result that 25-30 per cent. of Liebermann's isocinnamic acid, m.p. 58°, is produced. Allocinnamic acid in benzine is converted into ordinary cinnamic acid under similar conditions. Also fumaric acid changes to maleic acid in eight days, but the conversion of mesaconic acid into citraconic acid is very difficult, these being a-methylated acids. When stilbene in benzene is exposed to ultra violet light for eight days, it is converted to the extent of about 90 per cent. into isostilbene, which can be reconverted into stilbene by heating at 170-180° for one hour, by the vapor of fuming nitric acid in a few minutes, and quantitatively by exposure to sunlight of its solution in carbon disulphide containing a trace of bromine.

According to *Stoermer, Frederici, Brautigam* and *Neckel* (Ber. 1911, *44*, 637) the stable, less fusible forms of the following compounds are transformed into the labile or more fusible stereoisomerides when their benzene or alcoholic solutions are exposed to the action of the ultra violet rays from a uviol lamp for several days; coumaric acid, 75; methylcoumaric acid 75; ethylcoumaric acid over 90; propylcoumaric acid, 85; methylcoumaramide, 50; ethylcouramaramide 100, propylcouramaramide 95; methyl courmarate coumarin aceylcoumaric acid, over 90; methyl benzoylcoumarate; methyl oc-o-nitri-o-methoxycinnamate, 80; L-o-nitro-o methoxycoumaric acid, 40; p-methoxycinnamic acid, 25; sodium o-chlorocinnamate, 10; piperonylacrylic acid, 17; maleic acid; o-anisylcinnamic acid, 35-40; o-anisylcinnamide, 70; o-anisylcinnam-methylamide, 36, and the corresponding ethylamide, 40; B-o-anisyl-a-methylcinnamic acid, 5, and the corresponding amide, 5; cinnamic isocinnamic acid m.p. 42°, 30-40; phenyl tolyl ketoxime, 40; phenyl anisyl ketoxime. In most cases the reaction is a balanced one, and the number given for each compound represents the percentage for the less fusible compound which has been transformed when equilibrium is established. Crotonic acid is not transformed to any appreciable extent.

The method is recommended as a suitable one for the preparation of allo-stereoisomerides in several cases and also for the detection of spatial isomerism between a pair of compounds. In a few instances the addition of methyl or ethyl alcohol to the unsaturated compounds occurs during the exposure to the ultraviolet light, but the amounts of such products are usually small. It is suggested that the transformation and the percentage amount transformed depends on the energy differences between the steroisomerides. Sodium fumarate is not transformed, although the corresponding acid yields 30 per cent. of maleic acid. These investigators also state that o-chlorocinnamic acid, or its sodium salt, when exposed to ultra violet light is partly transformed into the allo-acid, $C_9H_7O_2Cl$, but when glacial acetic acid solutions are used, part of the acid combines with acetic acid, giving a product, $C_{11}H_{11}O_4Cl$, m.p. 212-213°. When a solution of mesaconic acid is subjected to the action of ultra violet light, water or methyl alcohol appears to combine with the acid.

Phenolphthalin.

Phenolphthalein is reduced to phenolphthalin by the action of nascent hydrogen. According to *Rossi* (Chem. Zentr. 1911, ii, 1659; from Giorn. Farm. Chim., 1911, 60, 433; J. Chem. Soc. 1912, Abs. *102*, ii, 107) while the reverse reaction takes place in the presence of hydrogen peroxide, and may be employed for the detection of blood. In the absence of the latter, the oxidation proceeds very slowly and may take days, but when blood is present the action is much more rapid. The test is carried out as follows: An alkaline solution of phenolphthalein is shaken with zinc dust until colorless, filtered, and the filtrate mixed with the solution to be tested, to which a few c.c. of 12 per cent. hydrogen peroxide have been added previously. If blood is present, a red coloration develops within three hours. Exposure to bright light, such as an arc-light, also increases the rapidity of the oxidation of phenolphthalin.

Santonin.

Piutti (Atti. R. Accad. Lincei, 1913, [v] 22, ii, 92-204; J. Chem. Soc. 1913, Abs, 104, ii, 896) states that carbon electrodes which have been alternately heated to redness and immersed in ferric choride solution a few times, or a carbon and an iron electrode, may be employed with advantage instead of iron electrodes for the arc used as a source of light in certain ultra violet light experiments. The curves obtained indicate that the transformation of santonin into photosantonic acid and isophotosantonic acid by light proceeds by way of intermediate compounds. Photosantonic acid and probably also isophotosantonic acid. are very transparent to the ultra violet rays, but santonin is not. No confirmation could be obtained of the alleged re-conversion of yellow santonin into white on boiling. The alleged visible alteration of santonin crystals under the action of light could not be observed. Asparagine, lactic acid, and carbamide are said to be almost completely transparent to the light of the iron arc.

Phototropy of Fulgides and Other Compounds.

Fulgides, containing aromatic substituting groups are reported by *Stobbe* (Annalen, 1908, 359, 1, J. Chem. Soc. 1908, Abs. 94, ii., 339) to undergo change in color when exposed to light. Thus triphenylfulgide, which forms pleochroic, orange-red, monocline crystals, becomes dark brown when exposed to sunlight or the rays of an arc lamp, changing again to its original color in the dark. The brown and orange modifications are chemically identical, and differ only in the solid state. Such phenomena have been termed by Marckwald (Zeit. physikal. Chem. 1899, 30. 140) phototropy. If this phototropic change is frequently repeated, the difference between the shades of the two forms becomes gradually less, a chemical change taking place which leads finally to the complete conversion of the fulgide into a new substance, the photoanhydride. To study the action of light waves of different lengths, the fulgide is exposed in a thin layer between two glass plates in a special spectrographic apparatus. Orange-yellow triphenyfulgide, when exposed to the light of the spectrum, after two minutes shows a broad band between the spectrum lines E and G, which after prolonged exposure gradually extends towards the ultra violet. The yellow modification is sensitive to blue and violet light rays, but a blackish-brown form which is intermediate between the yellow and brown modification is sensitive to yellow and red rays. The portion of the spectrum which causes the phototropic change from the yellow into the brown modifications is termed the zone of stimulation. The behavior of a number of di- and tri-arylfulgides towards the light rays of different wave-lengths has been studied in this manner. Phototropic change has been observed only with the lemon-yellow to orange-red diaryl—and the orange-red to dark red triarylfulgides; the colorless alphyl, greenish-yellow to yellow monoaryl, and red, purple-red, or brown or tetra-arylfulgides are not phototropic.

The modifications of a phototropic substance can exist in the pure state only when exposed to light rays of the wave-length under the influence of which they are formed. Under all other conditions, the substance is a mixture or solid of the one form in the other. The phototropic change is caused by the light rays which are absorbed by the modification undergoing the change. Hence the brown form of triphenylfulgide must be in reality blue, the brown appearance resulting from its state of granulation. The equilibrium between the two modifications in a mixture depends on the wave-lengths of the light to which it is exposed. It follows that the parts of the spectrum which produce the phototropic change depend on the colour of the fulgide, the zone of stimulation lying the more towards the violet the deeper the normal shade of the substance, and that the amount of change in the colour of a phototropic fulgide not only increases with diminishing wave-lengths of the light rays and with increasing intensity of illumination, but diminishes with increasing temperature and depends, further, on the number and nature of the substituting groups, being greatest with diphenyl-o-methoxyphenyl-diphenyl-piperonylallo-, and diphenyl-o-nitrophenylfulgides, less with diphenyl-o-methoxyphenylfulgide, and least with the diarylfulgides. The furyl-fulgides resemble the phenyl compounds.

The phototropy of other substances has been studied in a similar manner. The zone of stimulation for colorless B-tetrachloro-æ-ketonaphthalene lies in the ultra violet, whilst the reverse change is caused by yellowish-green or yellowish rays. Red and blue rays have no action.

Phenylbenzylidenehydrazine, which forms light yellow crystals or a white powder, becomes red on exposure to violet or ultra violet rays, becoming again colorless when exposed to yellow or green light. Phenylanisylidene- and phenylcuminylidene- hydrazines behave in the same manner, as do also osazones of the benzil series (Biltz and Wienands, Abs., 1899, i, 910). Tetraphenyldihydrotriazine (Walther, Abstr., 1903, i, 592) and ethyl oxalisobutyrate (Wislicenus and Kiesewetter, Abstr., 1898, i, 240) have also been observed to exhibit phototropy.

Nature of Bleaching.

When a system sensitive to light absorbs light very strongly and becomes bleached as a result of the chemical change, thus allowing the light to act on deeper layers, it should be possible according to *Plotnikoff* (Zeitsch. physikal. Chem. 1911, 78, 293; J. Chem. Soc. 1912, Abs. 102, ii, 4) to follow the rate of the reaction from the rate of bleaching of the solution. This is realized in the combination of bromine with cinnamic acid in benzene solution. A glass tube was filled with the solution, and the end closed with a glass plate placed horizontally, and light from a uviol lamp allowed to enter from the end through the glass cover, access of light to the sides and the other end being carefully guarded against In these circumstances bleaching proceeds gradually from the illuminated end until the solution is completely decolorised.

Cause of Bleaching of Dyes.

Gebhard (Zeitsch, angew. Chem. 1910, *23*, 820; J. Chem. Soc. 1910, Abs. 98, ii, 405) has confirmed the theory (Zeitsch. angew. Chem. 1910, *22*, 2484) that the bleaching of dye solutions or of dyed tissues by light is due to the primary formation of a peroxide of the dye. The peroxide is best detected by acidified potassium iodide and starch, by alkaline potassium permanganate, or by diphenylamine and concentrated sulphuric acid. Chromic, molybdic and titanic acids do not indicate the presence of a peroxide, which fact furnishes one of Gebhard's several arguments against the theory of the primary formation of hydrogen peroxide. The rays which are most effective in the production of the peroxide are those complementary to the color of the dye. Blue, violet and ultra violet rays exert a decomposing action on the peroxide, or occasion a transference of the active oxygen to unattacked molecules of the dye. Gebhard utilises Mumm's theory of oxidation in the presence of water and shows by an electrolytic experiment that the perhydroxyions are instrumental in bleaching the dye.

Dye Solutions.

In liquids exposed to the action of light, condensation nuclei are formed. These bring about local increases in concentration and accelerate chemical reactions which do not take place in the dark. According to *Weigert* (Ber. 1910, *43*, 164) proof of the formation of condensation nuclei is afforded by the fact that solutions of dyes exposed to light show an increased solvent action towards gases.

The dyes studied were uranin, erthrosin-G and -J, phloxin, methyl-violet and malachite-green. These were enclosed in tubes with nitrogen, maintained at 15°, and exposed to the light from a mercury lamp. A manometer was arranged to indicate the gas pressure in the tubes, which were constantly shaken. The solubility of nitrogen in water is not affected by exposure to light. In the dye solution a decrease in pressure took place, at first with constant velocity, but subsequently becoming slower. After keeping the tubes in the dark again, an increase in pressure was found, but the original value was never attained. A special differential-absorptiometer was designed to remove the absorbed. The amount of dye present in solution is far was found possible to recover only a portion of the gas absorbed. The amount ofdye present in solution is far too small to explain the increased solubility of the gas as due to the influence of the dyes. Undoubtedly, condensation nuclei form, and the nitrogen condenses at their surface.

Chlorophyll.

Alcoholic solutions of chlorophyll (from spinach) in quartz vessels were exposed by *Bierry* and *Larguier des Bancels* (Compt. rend., 1911, 153, 124-125; J. Chem. Soc., 1911, Abs., *100*, 735), to the light of two mercury vapor lamps for twenty-four to forty-eight hours. The solutions became faintly yellow and no longer showed the absorption bands characteristic of chlorophyll. Tests for urobilinogen were applied, with positive results. A benzene solution of chlorophyll became colorless under the same conditions, but did not show the color reactions of unrobilinogen.

It has been previously shown that only the rays actually absorbed are causative of the decolorization of chlorophyll. According to *Dangeard* (Compt. rend., 1913, 156, 1844) when light is allowed to act on a mixture of chlorophyll and pinaverdol, the latter is first decolorised at its own absorption band, from which it follows that the latter is attacked and finally destroyed through the energy absorbed by the chlorophyll, and not by that absorbed itself. The experiments have been extended to a variety of colored substances, with the general result that radiations which are completely inactive towards a pure substance are found to become active in the presence of a second pigment. Since chlorophyll in the plant is accompanied by various yellow pigments, such as carotine and xanthopyll, and decolorization is complete at the bands I, II, III and IV, it follows that these pigments are also attacked and ultimately decomposed through the energy absorbed by the chlorophyll.

Selective Destruction of Enzymes.

Malt amylase is found by *Chauchard* and *Mazour* (Compt. rend., 1911, *152*, 1709) to be much more sensitive to ultra violet light than the invertase from yeast. It is therefore possible by exposing a mixture of the two to the light from a quartz-mercury lamp to destroy the activity of one before that of the other.

Resins.

From the results of a series of preliminary investigations *Vignolo-Lutati* (Atti. R. Accad. Sci. Torino, 1912, *47*, 841; J. Chem. Soc. 1912, Abs. 102 ii, 882) draws the conclusion that the photochemical action of resins is both chemical and physico-chemical in character. Either the formation of ozone or peroxide during the auto-oxidation of resins, or some other modification in their chemical equilibrium, is apparently accompanied by the emission of rays of very short wave-length, to which the photochemical efforts are due.

Colored Resinates.

The solubility of colored resinates submitted to the action of light has been investigated by *Larguier des Bancels* (Comp. rend., 1912, 155, 280; J. Chem. Soc. 1812, Abs. 102, ii, 882). Colored resinates are prepared by treating resin with aqueous solutions of alkali hydroxides, adding a suitable coloring matter (safranine, rhodamine, etc.), and then precipitating with a salt of zinc or magnesium. These substances when dissolved in terebene, spread in a thin layer on glass plates, dried, and exposed to the light of the sun or of a mercury vapor lamp, became, at the end of a certain time, insoluble in such solvents as benzene, but soluble in solvents such as methyl or ethyl alcohol. This effect on the solubility is produced essentially by radiations of short wave-length and also depends on the drying, since, if this is pushed too far, the non-illuminated resinates dissolve in alcohol.

Fehling's Solution.

According to Byk, Fehling's solution is decomposed by light of wave-lengths less than 400 $\mu\mu$, corresponding with an absorption band in the ultra violet, whereas the red and yellow waves of the visible absorption bands have no action. This is contrary to the rule that radiations which are absorbed by a substance tend to destroy it.

It is suggested that the red light absorbed by Fehling's solution is not active enough to produce a decomposition unaided, whereas in presence of a suitable reducing agent its activity might be sufficiently reinforced for it to do so.

In accordance with this suggestion *Leighton* (J. Physikal. Chem. 1913, *17*, 205; J. Chem. Soc. 1913, Abs. 104, ii, 459) finds that in presence of quinol within certain very narrow limits of concentration Fehling's solution is reduced by red light, but is stable in the dark.

Ozone.

When a tube of fused quartz was exhausted until the pressure registered only a few millimeters and charged from an induction coil, *Goldstein* (Ber., 1903, 36, 3042) observed an intense odor of ozone in the surrounding atmosphere, and iodized starch paper was turned blue quickly. The odor of ozone was not perceptible when the pressure inside the tube exceeded a certain value; it was perceptible at very small pressures, and was not intense when the light from the discharge was at its brightest. The phenomenon is ascribed to the ultra violet light rays of small wave-length penetrating the quartz and then converting the atmospheric oxygen into ozone. A Geissler tube was exhausted and oxygen was passed into it until the pressure registered several centimeters. The tube was then partially immersed in liquid air and charged from an induction tube. After ½ min., the tube became luminous until the pressure was several centimeters and the sparking continued. By repeated treatment in this manner, oxygen can be entirely converted into ozone, which was obtained as a dark blue liquid. The spectrum of pure oxygen may readily be investigated by the aid of this method, since organic substances present are attacked by the ozone, even at the temperature of liquid air. Goldstein notes that Lenard (Drudes Ann. d. Physik. 1, 486, 1900) had observed that ozone was formed by the action on air of sparks from a Leyden jar. The formation of ozone in greatly rarefied air by the method employed by Goldstein was first reported by the latter.

Bordier and Nogier (Compt. rend., 1908, 147, 354) could not find that ozone was produced from the oxygen of the air by action of ultra violet light, although others had observed its formation. Using a quartz mercury lamp as the source of ultra violet light, *Aubel* (Compt. rend., 1909, 149, 983; 1910, 150,

96) definitely proved that ozone is produced. Instead of using water to absorb the ozone, olive oil and light petroleum were employed in the first experiments, being placed in porcelain dishes inside a large glass globe surrounding the quartz tube. After several hours' exposure starch iodide showed the presence of ozone in these liquids. When distilled water was submitted to the action of the ultra violet light for fourteen hours, the presence of ozone was detected by its action on a photographic plate. Starch iodide paper was turned blue in two minutes, except where it was covered with a piece of quartz, and thus prevented from coming into direct contact with the ozonized air. In the experiments where water was used to absorb the ozone produced, the resulting solution contains hydrogen peroxide, the presence of which was detected by its action on the photographic plate. The presence of hydrogen peroxide in the water is claimed to prove the formation of ozone in the air by the action of the ultra violet light.

Bahr (Ann. Physik. 1910, (iv), 33, 598; J. Chem. Soc. Abs. 1910, 98, ii, 949) exposed ozonized oxygen to ultra violet light from a quartz-mercury lamp and measured the rate at which the ozone was decomposed. The rate of decomposition increases rapidly as the pressure on the gas is reduced. For a given intensity of the incident ultra violet radiation, the ozone disappears at a rate which agrees with the requirements of the equation for a unimolecular change, if the pressure is kept constant. In consequence of the decomposing action of ultra violet light, the measurement of the absorption of ultra violet radiation cannot be applied to the estimation of ozone at low temperatures.

Weigert (Zeitsch. Elektrochem. 1912, 18, 654) also describes a method by which the sensitiveness of the reaction of decomposition of ozone in ultra violet light can be compared with that in visible light. The sensitiveness, as measured by the amount of decomposition under conditions otherwise comparable, is 2.3×10^8 mol. per cal. in ultra violet light, and 4.8×10^{10} mol. per cal. in ordinary light in the presence of chlorine as sensitiser.

Weigert (Ber., 1913, 46, 815) has stated that in order to investigate the photochemical reaction of ozone with hydrogen it is necessary to use that part of the spectrum where ozonization of oxygen does not occur. This he attained by using a quartz-mercury lamp, and allowing the rays to pass through a layer of air before entering the reaction vessel. No trace of hydrogen peroxide was formed and there was only an extremely slow reaction in the dark. In ultra violet light, however, about one-third of the ozone originally present disappeared in two minutes, the disappearance being due to the two reactions: $2O_3 = 3O_2$ and $H_2 + O_3 = H_2O + O_3$. The total amount of ozone decomposed is proportional to the ozone concentration.

The results indicate that in the activation of oxygen by ultra violet rays two photochemical reactions occur. In the formation of water from hydrogen and oxygen, the oxygen is first ozonized by the short rays, and then reacts with hydrogen under the influence of the long rays. In the photochemical dissociation of water vapor a further photochemical reaction plays a part, namely,

$$H_2O = H_2 + O,$$

which is effected by the short rays.

It is possible that the deviation of the nitric oxide equilibrium from the position calculated thermochemically is due to the photochemical action between nitrogen and ozone, the latter being formed from oxygen by the ultra violet rays.

A further study of these reactions by *Weigert* and *Bohm* (Zeitsch. physikal. Chem. 1915, 90, 189) on mixtures of ozone and dry hydrogen, containing from 2.4% to 92.5% hydrogen, using a quartz-mercury lamp operating at 6 amperes and 65 volts, has furnished additional details. The gas was passed in a stream along a tube which was of such dimensions that it contained sufficient ozone to absorb completely the whole of the photochemically active light light, particularly that with wave-length about $258\mu\mu$. By means of these experiments the catalytic influence of ultra violet rays on the simultaneous ozone decomposition and water formation in the mixtures was carefully studied. By measuring the volume change occasioned by illumination, and by analysis of the gas mixture before and after illumination, it was shown to be possible to determine the extent to which both changes had taken place. It is shown that when the gaseous mixture is kept in the dark no reaction of any kind takes place between ozone and hydrogen. On illumination, the two reactions (I), $2O_3 = 3O_2$ and (II), $H_2 + O_3 = H_2O + O_2$ occur, as stated above, and further, the reaction (III), $2O_3 + H_2 = H_2O_2 + 2O_2$, cannot be observed under the experimental conditions. A consideration of the volume changes which occur on illumination show that with a large excess of hydrogen the reaction takes place mainly according to equation (II), but with larger quantities of ozone equation (I) represents the major portion of the reaction. Equation (I) is accompanied by an increase in volume, whereas equation (II) is accompanied by a decrease. At the point where there is neither contraction nor increase in volume, it is shown that of three molecules of ozone reacting, two react according to equation (I) and one according to equation (II). The photochemical decomposition of ozone in the absence of hydrogen is a relatively slow process, but it is strongly accelerated by even small quantities of hydrogen. With a small quantity of hydrogen, the velocity of decomposition of ozone is proportional to the ozone concentration, and from 8% hydrogen upwards it is independent of the hydrogen concentration. With a large excess of hydrogen the order of the reaction is greater than unity, but with larger ozone concentrations it is less than unity. From this it is shown that the effect of two simultaneously occurring photochemical reactions cannot be regarded as the sum of the two single effects. The photochemical water formation is proportional to the ozone concentration for low concentrations of ozone, but at higher concentrations it approaches a limiting value, which lies higher, the higher the partial pressure of the hydrogen. With a constant ozone concentration the water formation is approximately proportional to the hydrogen concentration. With an excess of hydrogen of about one hundred times the quantity required for the formation of water according to equation (II), the reaction proceeds practically entirely according to this equation.

Jobling (Martin's Industrial Gases, New York, 1916, 134) gives Lenard the credit of the discovery that air or oxygen is "activated" by ultra violet light and calls attention to a photochemical method of making ozone proposed by Potter (U. S. Patent 845,965) involving the construction of an ozonizer in which a quartz-mercury vapor lamp is surrounded by a sheathing of ordinary glass, between which and the quartz wall of the lamp, air is spirally conducted. For industrial purposes, Jobling states the only practical method of producing ozone is that of passing dry air through a chamber where it can be subjected to the influence of a silent high-tension electric discharge. It is not certain whether the production of ozone by silent discharge is fundamentally an electrolytic phenomenon, dependent upon the electric stress developed, or whether it is to be attributed to the ultra violet rays developed. The latter is the more probable. (Harries).

Origin of Atmospheric Ozone.

From a series of experiments on the origin of atmospheric ozone *Henriet* and *Bonyssy* (Compt. rend., 1908, 146, 977; J. Chem. Soc. 1908, Abs. 94, ii, 578) conclude that ozone is formed at the expense of the oxygen of the high regions of the atmosphere under the influence of the ultra violet rays of the sun and is carried to the lower layers of the air by winds and rain. The proportion of ozone in the air is at a maximum during a West or Southwest wind and at a minimum during an East wind, and it is also increased during clear, calm weather by the direct action of the solar radiations on the lower layers of air.

Ozone and Chlorine.

The decomposition of ozone by light in presence of chlorine has been studied quantitatively by *Weigert* (Zeitsch. Electrochem., 1908, 14, 591), the light of a mercury quartz lamp being used, and the rate of decomposition being measured by means of the change of pressure of the gas. There is no induction period, and decomposition stops when the gas is cut off. The rate of decomposition is independent of the concentration of the chlorine, but not in proportion to it, and it is nearly proportional to the intensity of the light. By placing a vessel containing chlorine between the source of light and the ozone tube, a measurement of the quantity of light absorbed by the chlorine is obtained; in this way it is shown that the rate of decomposition of the ozone is proportional to the quantity of light absorbed by the chlorine mixed with it. A rise of temperature of 10° increases the rate of reaction 1.17 times. It is suggested that the light produces some intermediate product which is destroyed rapidly by the action of ozone; the rate of decomposition measured is then the rate of formation of this product, which is independent of the concentration of the ozone.

Formation of Water.

Under the action of ultra violet light at 150°, hydrogen and oxygen combine almost completely, with the formation of water vapor. Although combination takes place with considerable velocity, there is no explosion. At the same temperature, water vapor is decomposed by ultra violet light to a very small extent, the minimum decomposition found to be 0.00087-0.0010%. This amount of decomposition is the same as the thermal decomposition existing at about 1,250°, so that the equilibrium under the influence of ultra violet light is different from the ordinary thermal equilibrium (Coehn, Ber., 1910, 43, 880).

After discussing recent work on the chemical effects of ultra violet light, *Andrèeff* (J. Russ. Phys. Chem. Soc., 1911, 43, 1342; J. Chem. Soc. 1912, Abs. 102, ii, 112) describes his own experiments which have been carried out with a mercury lamp at various voltages and currents.

With a voltage of 220, hydrogen and oxygen combine to form water with moderate rapidity. The velocity of the reaction, which terminates in from five to twenty hours, is independent of the concentrations of the reacting substances, and is in good agreement with the expression $dx/dt = C$; it increases almost proportionately with the intensity of the light. The mean value of the temperature-coefficient of the reaction is 1.1.

Water also decomposes under the influence of ultra violet light, in the field of action of which an equilibrium is established between hydrogen, oxygen and water, this equilibrium differing from the thermal equilibrium at the corresponding temperature. When the initial product is a mixture of hydrogen (2 vols.) and oxygen (1 vol.) the final position of equilibrium is the same as when water is employed. With increase of the intensity of the ultra violet light, the equilibrium is displaced in the direction of the dissociation, and the percentage of water decomposed increases proportionately with the increase of intensity.

Photo-Electric Properties of Water.

Experiments are described by *Obolensky* (Ann. Physik, 1912, (iv) 39, 961; J. Chem. Soc. 1913, Abs., 104, ii, 3) which show that water is photo-electrically sensitive to ultra violet rays of very short wave-length. The ultra violet light was obtained from the spark discharge between aluminum electrodes, and by the interposition of screens of fluorspar quartz, air, calcspar, glass and gypsum, it was possible to eliminate portions of the ultra violet spectrum in a series of stages. In this way it has been found that the most active rays are those of the extreme ultra violet region in the neighborhood of $\lambda = 130\ \mu\mu$. For this group of rays, the photo-electric activity of water is about 1/400th of that cupric oxide. As the wave-length increases, the exciting power of the rays falls off very quickly, and vanishes completely when exceeds 202.5 $\mu\mu$.

The addition of small quantities of acids, bases and salts has no apreciable influence on the photo-electric activity of water. In larger quantities, chlorides diminish the effect, while sulphates, carbonates and nitrates increase it. The presence of the dissolved salts also causes a displacement of the spectral position of the rays which exert the maximum effect. Ice is more photo-electrically sensitive than water. For the unfiltered rays from the aluminum spark discharge, its activity is about 0.7 of that of cupric oxide, and for the group of rays in the neighborhood of $\lambda = 180\,\mu\mu$, it surpasses cupric oxide in its sensitiveness. Experiments with hoar-frost show that this behaves very similarly to ice. The meterological significance of the observations is referred to.

Hydrogen Peroxide.

Henri and *Wurmser* (Compt. rend., 1913, 157, 126) have made a study of the photochemical decomposition of hydrogen peroxide by monochromatic light from the ultra violet portion of the spectrum. The results confirm those of Tian for total light, that the reaction is unimolecular, and that the velocity of decomposition is proportional to the concentration. For each wave-length the velocity is proportional to the incident energy. It is further proportion to the absorbed energy, the factor being constant for wave-lengths between 2,800 and 2,050, the photochemical susceptability varying proportionately with the absorption.

Henri and *Wurmser* (Compt. Rend., 1913, 157, 284) further state that the addition of traces of numerous different substances to hydrogen peroxide renders it stable towards ultra violet rays, alkalies being more active than acids in this respect. Henri and Wurmser suggest that in many of the cases of catalysis by ferments and colloidal metals, the action of poisons is on the substances undergoing transformation, and not on the catalyst itself. Further, that the action of certain ferments is quite comparable to that of the ultra violet rays. *(To be continued in the July issue.)*

U. S. Tariff Commission Completes Coal-Tar Products Census

The United States Tariff Commission announces the completion of its census of coal-tar products for 1917. This group of products include, not only the coal-tar dyes and the crude and intermediate materials required for their manufacture, but also all the medicinal and photographic chemicals, explosives, synthetic resins, synthetic perfume materials, and flavors which are in any way derived from coal-tar products. There were produced in the United States (not inclusive of explosives and synthetic phenolic resins) 54,367,994 pounds of dyes and other finished products, which have a total value of $68,711,228. The production of the materials known as intermediates amounted to just 322,650,531 pounds, with a value of $106,942,918.

The annual production was reported for the following groups of products made in whole or in part from materials derived from coal tar: 45,977,246 pounds of dyes valued at $57,796,027; 5,092,558 pounds of color lakes valued at $2,764,064; 2,236,161 pounds of medicinal chemicals valued at $5,560,237; 779,416 pounds of flavors valued at $1,862,456; 263,068 pounds of photographic chemicals valued at $602,281, and 19,545 pounds of perfume materials valued at $125,960.

There were 81 establishments engaged in the manufacture of coal-tar dyes in 1917 and their production during that year was practically identical with the amounts annually imported before the war. The imports of the fiscal year 1914 amounted to 45,840,866 pounds and the production in the United States in 1917 was 45,977,246 pounds. However, an analysis of this total reveals that the domestic production, though equal in quantity to the preceding imports, differs in the relative amounts of the various classes of dyes. Only a small production was reported for indigo, and the alizarin and vat dyes derived from anthracene and carbazol,—classes of dyes which include some of the best and fastest colors known to the textile trade. The United States produced only 2,166,887 pounds of these dyes in 1917; and the elimination of 1,876,787 pounds of extract made from imported indigo, reduces the output of these dyes to less than three per cent. of the pre-war imports. Dyes of this class are dutiable at 30 per cent. in the Tariff Act of 1916. The lack of development in the manufacture of these particular dyes promises to be remedied to a considerable extent in 1918, for a number of firms have begun their manufacture and a large increase in production can clearly be foreseen.

In the classes of dyes which if imported would be dutiable at 30 per cent. plus five cents a pound, the American manufacturers have shown remarkable progress, producing 43,810,359 pounds at a total value of $57,639,990. That this represents something of an excess over the American needs is evidenced by the fact that during the fiscal year 1917, American-made dyes to the value of $11,509,287 were exported to other countries. Thus the exports exceeded the pre-war imports in total value, although not in tonnage nor in the variety of the dyes.

The development of the manufacture of intermediates is equally marked, for before the war almost all of these necessary materials were imported from Germany. The Tariff Commission finds that intermediates were manufactured by 117 firms in 1917 and that the production amounted to 322,650,531 pounds valued at $106,942,918. These figures, however, are somewhat misleading, as there is inevitable duplication in the totals. It is well known that many of the intermediates are derived from other products of the same class. Thus starting with benzol the following succession of products is obtained: nitrobenzol, anilin,

(Concluded on page 274.)

NEW PUBLICATIONS

Protecting the Eyes from Injurious Radiations

The new publication of the U. S. Bureau of Standards (Technologic Paper No. 93) entitled "Glasses for Protecting the Eyes from Injurious Radiations" is the second and an enlarged edition of this work, which was prepared by W.W . Coblentz and W. B. Emerson, of the Bureau.

It contains considerable new data on the spectral transmission of glasses suitable for protecting the eyes from injurious rays, e. g., euphos, fieuzal, akopos, and noviweld glasses. An appendix is added which gives the transmission of the radiations from a gas-filled tungsten lamp; a magnetite arc, and a quartz mercury vapor lamp through various glasses, thus showing in a condensed table the protective properties afforded by these glasses. This paper is now ready for distribution and those interested may obtain a copy by addressing a request to the Bureau.

Report on Technology of Salt Making

The rumor that the United States some time ago was threatened with a famine in salt was baseless, according to a report on the technology of salt making in the United States, recently issued by the Bureau of Mines, Department of the Interior. W. C. Phalen, mineral technologist, the author of the bulletin, reviews the industry and draws certain conclusions from visits to the operating plants in the United States. One of these conclusions is that there is an excess of plant capacity as compared with domestic requirements.

Mr. Phalen says:—"The consensus of opinion seemed to be that much more salt was being produced than could be marketed, estimates of over production ranging from 25 to 50 per cent. The facts that large up-to-date plants were not working at full capacity, that others were working at half time or half capacity, and that others were either temporarily or permantly closed are significant to those planning to enter the salt business. These statements, of course, apply to the normal conditions which obtained before the war.

"The keenness of competition in the salt industry prevents tying up large stocks and cornering the market which is further prevented by the great abundance of this natural commodity, its widespread distribution and the fact that its production is not restricted to a few manufacurers, but is in the hands of many independent producers. It follows, therefore, that a scarcity of salt in any part of the United States is due, not to a possible shortage of the original supply of salt itself, but to other factors entering into the salt industry, such as shortage of labor, fuel and difficulties in transportation.

"The imporance of the industry needs no comment. The domestic output in the United States in 1916 was nearly 6,400,000 short tons, and it is estimated that in 1917, it will be nearly 6,950,000 short tons. The industry is scattered over fourteen states, distributed from coast to coast and from the Great Lakes to the Gulf. The low value of the commodity has prevented its transportation to considerable distances, except where local prejudice has favored a certain brand. This competition has lead to loss.

"The United States has produced in recent years very nearly all the salt it has consumed. The small importations, usually not more than two or three per cent. of the total consumption, have come to the Atlantic seaboard. This illustrates how, in the case of a low-priced and abundant commodity, freight rates regulate distribution and competition, not only among domestic producers, but from foreign sources as well.

"The rapid deterioration of equipment is another item in the salt business which has received consideration in the report. The wear and tear on all salt-making machinery is heavy. If a plant is allowed to remain idle for any considerable length of time, it is well-nigh ruined. For this reason it may often be cheaper to make salt for a season without profit than to shut down. In figuring costs and basing selling prices on them, some producers have not provided for the rapid deterioration of plant, and this, together with over production, has caused losses among salt manufacturers during the past decade."

Portland Cement with High Magnesia Content

A new publication has been issued by the U. S. Bureau of Standards (Technologic Paper No. 102) entitled "The Properties of Portland Cement Having a High Magnesia Content."

A series of cements was burned in the Bureau's experimental rotary kiln in which the limestone used in the raw material was replaced in part or in whole by dolomite. A magnesia content as high as 25 per cent. was obtained in the resulting cement and the clinker was examined petrographically. The constituents present, their amount, and the character of their formation were carefully studied. The clinker was also ground and the resulting cement subjected to the usual tests for physical properties. The results show that cements not exceeding 8 per cent. in magnesia content will produce concretes of satisfactory strength at the end of 1½ years. With this amount of magnesia, monticellite and spinel (constituents not present in cements of lower magnesia content) appear; and these cements seem to hydrate with a large increase in volume. The publication is a part of the program of the systematic investigations on the technology of Portland cement.

This paper is ready for distribution and those interested may obtain a copy by addressing a request to the Bureau.

New Publications of the U. S. Bureau of Mines

(List 58.—May, 1918.)

BULLETINS.

Bulletin 110. Concentration experiments on the siliceous red hematites of the Birmingham District, Ala., by J. T. Singewald, Jr. 1917. 81 pp., 1 pl., 47 figs.

Bulletin 132. Siliceous dust in relation to pulmonary disease among miners in the Joplin District, Mo., by Edwin Higgins, A. J. Lanza, F. B. Laney, and G. S. Rice. 1917. 115 pp., 6 pls., 6 figs.

Bulletin 146. Technology of salt making in the United States, by W. C. Phalen. 1917. 149 pp., 24 pls., 10 figs.

TECHNICAL PAPERS.

Technical Paper 148. The determination of moisture in coke, by A. C. Fieldner and W. A. Selvig. 1917. 14 pp.

Technical Paper 182. Flotation of chalcopyrite in chalcopyrite-pyrrhotite ores of Southern Oregon, by Will H. Coghill. 1918. 13 pp., 1 fig.

Technical Paper 183. New views of the combustion of the volatile matter in coal, by S. H. Katz. 1918. 15 pp., 1 fig.

Technical Paper 201. Accidents at metallurgical works in the United States during the calendar year 1916, by Albert H. Fay. 1918. 18 pp.

NOTE.—Only a limited supply of these publications is available for free distribution, and applicants are asked to co-operate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers can not be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

Dimethylaniline and Diphenylamine

(Concluded from page 260.)

Diphenylamine is used in color making for the preparation of Orange IV, Diphenylamine Blue, certain sulphur blues, and other colors.

It is especially employed at present to lend stability to high explosives.

Its hexanitrated derivative is a more powerful explosive than picric acid, and merits the attention of the artillery authorities. It is not prepared by direct nitration of diphenylamine but by preparing to begin with asymetric dinitrodiphenylamine, which is obtained by condensing the dinitrochlorobenzene, 1 : 2 : 4, with anilme, then nitrating this as far as the process can be carried.

By methylation diphenylamine gives methyl-diphenylamine, which has found a limited employment in color making. This is prepared by heating in an autoclave a mixture of 100 kilos of diphenylamine, 68 kilos of hydrochloric acid, and 24 kilos of methyl alcohol for ten hours at 250° to 300° C., and at a pressure of 10 to 15 kilos per square centimetre.

Technical Men Unite

(Concluded from page 262)

Illinois Society of Engineers.

Illinois Society of Architects.

The American Railway Engineering Association.

The Swedish Engineers' Society of Chicago.

Illinois Chapter, American Institute of Architects.

Chicago Section, American Society of Mechanical Engineers.

Chicago Section, American Institute of Electrical Engineers.

Chicago Section, American Chemical Society.

Chicago Section, American Insitute of Mining Engineers.

Mid-West Section, Society of Automotive Engineers.

Illinois Association of American Society of Civil Engineers.

Chicago Section, American Society of Heating and Ventilating Engineers.

Chicago Section, American Society of Refrigerating Engineers.

Chicago Section, Steel Treating Research Society.

Chicago Section, Illuminating Engineering Society..

Chicago Chapter, American Association of Engineers.

Officers of the War Committee have been elected as follows:

Chairman—F. K. Copeland.

Vice-Chairman—W. L. Abbott.

Secretary—Edgar S. Nethercut.

Treasurer—William A. Fox.

The executive committee consists of F. K. Copeland, W. L. Abbott, William Hoskins C. A. Keller, Charles E. Lord, C. F. Loweth, Isham Randolph and Richard E. Schmidt. The address of the Secretary of the War Committee is 1735 Monadnock Block, Chicago.

New Electric Furnace

(Concluded from page 254)

tion of the zinc. The electric furnace is closed and these losses are avoided. It is estimated that the unnecessary losses in brass-making are more than $3,000,000 a year in normal times and perhaps $10,000,000 a year in war times. Another claim for the electric furnace is that it gives more healthful working conditions for the men.

The Michigan Smelting and Refining Co., Detroit, Mich., already has one of these furnaces in operation and has four more under construction. The C. B. Bohn Foundry Company of Detroit is building two of these furnaces.

Coal-Tar Census Completed

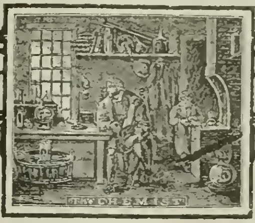
(Concluded from page 272.)

acetanilid, nitroacetanilid and nitranilin. Each of these products had to be reported by the manufacturer and hence there has been some cumulative counting.

The totals for all of the coal-tar products will be published in the final report.

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

CONDUCTED BY CHARLES B. DAVIS, F.C.S.



ALL classes of work covered by the following subjects will be done for readers of "The Chemical Engineer" through this department by Mr. Davis: Special research of every description; analysis and reproduction of any commercial product; prevention of waste and utilization of by-products on the most economical basis; valuation of raw materials; food analysis, and disputed points in regard to adulteration, labeling, and the enforcement of pure food laws; bacteriological and enzymatic examinations, including fermentation tests, pure yeast cultures, beverages of all kinds; development of chemical inventions and industrial processes; examinations and advice on special machinery.

Inquiries of a minor character will be answered on this page, while major matters involving personal investigations, analyses, etc., will, if desired, be treated confidentially through the mails. All questions, materials for analysis, or letters leading to the opening of negotiations for special work will receive prompt attention if addressed to

CHARLES B. DAVIS,
Care of "The Chemical Engineer," 118 East 28th Street,
New York City.

S. C. D.—Under separate cover I am forwarding you the complete details for your plant apparatus. For the heating kettle I have made provision for copper coils, since you desire to obtain quick changes of temperature.

The number of linear feet quoted will be found ample to temper the size charge you are going to treat.

As soon as I complete the working formula covering the process, I will make you a personal visit. In the meantime you will proceed with the plant erection.

L. S.—The samples of intermediates for the production of your Azo Dyes have arrived, and I shall proceed at once to test their purity and forward the results of my analysis at the earliest opportunity.

A. A. F.—The "Liquid Fire" used in the present war is a mixture of equal proportions of coal tar benzol and crude oil, contained in a tank under a pressure of 300 pounds per square inch of nitrogen gas. Nitrogen gas is used because it is inert to the oils.

W. A. S.—The price of aluminum as approved by the War Industries Board, is 32 cents a pound. This price is for lots of fifty tons and over, in the form of ingots, and of 98 to 99% grade.

W. B. P.—Salad oils of the type you mention in your letter are composed chiefly of a mixture of olive and cottonseed oils, or entirely of this latter ingredient. Send four ounce samples for the analysis, and I will forward results and opinion as to purity in a week or ten days.

K. T.—Yes, it is possible to produce pure BaO^2 by reducing the pure carbonate to ozid at red heat, and then reheating in an atmosphere of air, or better, pure oxygen.

A careful regulation of temperatures is absolutely essential.

J. W. K.—In accordance with your request, I have purchased in open market a sample of the skin salve mentioned, and on chemical analysis it shows the following composition:

Calomel	1.60%
Petroleum jelly	85.00
Mercuric Oxid	7.60
Water	5.80
	100.00

The mercuric oxid ingredient is poisonous to the skin, and I strongly condemn it for use as a salve.

E. T. D.—Your auto oil contains too much carbon and will foul your engine. The "flash point" and viscosity are also too high for proper combustion. You had better send me a few samples so that I may be in a position to advise you as to which to purchase in the future.

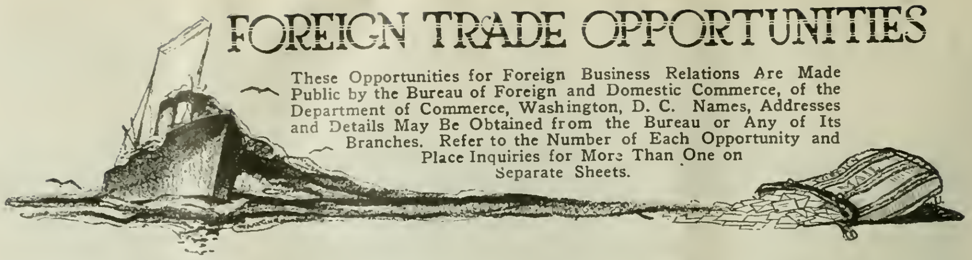
W. A. S.—Your request for the analysis of Pinus Palustris is given in full below:

Cellulose	58.48
Volatile Oil	1.30
Methyl Pentosan	3.60
Pentosan	7.46
Methoxy Groups	5.05
Soluble in 1% NaOH	22.36
" " Ether	6.32
" " Hot Water	7.15
" " Cold Water	6.20
Ash	0.37
Acetic Acid by Hydrolysis with 2.5% H_2SO_4	0.76

I have forwarded you the plans for the machinery, etc., under separate cover.

Charles B. Davis.

Those whose inquiries to this department have not as yet received attention must bear in mind that unless replies by mail are specifically requested, communications can only be considered in the order of their receipt.—Editor.



FOREIGN TRADE OPPORTUNITIES

These Opportunities for Foreign Business Relations Are Made Public by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, Washington, D. C. Names, Addresses and Details May Be Obtained from the Bureau or Any of Its Branches. Refer to the Number of Each Opportunity and Place Inquiries for More Than One on Separate Sheets.

Chemical Products.

26761.—An agency is desired by a man in Italy for the sale of machinery, chemical products, hardware, saws, etc. Correspondence may be in English.

Soaps and Perfumes.

26703.—An agency is desired by a firm in Ireland for the sale of toilet soaps and perfumery of all kinds. Quotations should be made f. o. b. Atlantic port. Goods should be packed in strong cases. Reference.

Chemical and Pharmateutical Products.

26683.—An agency is desired by a man in Italy for the sale of chemical, pharmaceutical and industrial products. Correspondence may be in English. References.

Tanning Extracts and Chemicals.

26684—A company in Switzerland wishes to purchase tanning extracts and chemicals used for tanning, fish oil, paraffin, alum, stearin, etc. Quotations should be made f. o. b. New York. Payment will be made by cash against documents. Correspondence may be in English. References.

Cement, Paints and Soap.

26642.—A company in Jamaica desires to buy and secure an agency for the sale of large quantities of hand forks, hoes, horseshoe nails, wire nails, tin, machetes, lumber, cement, paints, laundry soap, and bar iron. Correspondence may be in English.

Chemical Products and Oils.

26697.—A firm in Argentina desires to represent American manufacturers and exporters of canned goods cottenseed oil, lubricating oils, drugs, chemical products, sugar, canvas, jute bagging, string, rope, firearms, staves, boots and shoes, hardware, electrical supplies, and other goods. Correspondence should be in Spanish or Italian. References.

Greases, Oils and Kerosene.

26638.—An agency is desired by a man in France for sale of automobiles, motor trucks, motorcycles and accessories, industrial engines, agricultural machines and implements, machine tools, sewing machines, typewriters, hardware, industrial supplies, greases and oils, and kerosene. Payment will be made on delivery. Correspondence should be in French. References.

Chemical Products.

26754.—An agency is desired by a man in Italy for the sale of machinery and chemical products. Correspondence may be in English. References.

Anilines.

26755.—A company in Brazil wishes to secure exclusive agencies for the sale of tissues of all kinds, anilines, and preserved foodstuffs. Sample must be submitted in order to properly bring the goods to the attention of Brazilian firms.

Oils.

26691.—A man in Canada desires to purchase and secure an agency for the sale of cylinder and automobile oils of the best grade. Quotations may be made f. o. b. Boston. Correspondence may be in English Reference.

Chemicals and Carbon Black.

26702.—A firm in Switzerland is in the market for carbon black for printers, and chemicals for medicine and technical purposes, in large quantities. Payment will be made by cash against documents. Correspondence may be in English. Reference.

Papers and Parchment.

26632.—A man in Switzerland desires to purchase or secure an agency for the sale of colored silk paper, parchment, and all kinds of paper. Samples of the kind of papers desired may be examined at the Bureau or its district offices. (Refer to file No. 98355.) Correspondence may be in English. Reference.

Textiles, Paints, Chemicals, Etc.

26606.—A firm in Colombia desires to represent on a commission basis American manufacturers and exporters of woolen, cotton, and silk cloth; office supplies; painters' brushes, paints, varnishes, etc., in paste or powdered; chemicals and drugs; glassware, chinaware, stoneware, etc.; articles of plated silver, silver, and sterling silver; toys; canned goods, such as meats, fish, vegetables, fruits, etc.; clothing for children; articles for the manufacture of imitation jewels; hardware; gutter tiles; carpets and rugs; automobiles and accessories; knives, forks, and spoons; paper of all kinds; underwear; hats; ribbons; artificial flowers; window glass; and articles of aluminum ware. Reference.

DISTILLATES

News Notes of Chemical and Allied Industries

To Rebuild Sulphite Mill.

Preparations are being made to rebuild the sulphite mill at the plant of the International Paper Co., Watertown, N. Y., which was recently destroyed by fire with an estimated loss of $100,000.

Arthur Howe With Duriron Co.

The Duriron Castings Co. has secured the services of Arthur Howe, whose work in connection with the manufacture of acids and explosives is well known, in the capacity of consultant.

Chemists' Club's New Officers.

Officers elected for the coming year at the recent annual meeting of the Chemists' Club, New York City, are as follows: President, Ellwood Hendrick; Vice-President, Dr. Chas. H. Herty; non-resident Vice-President, Chas. L. Parsons; Secretary, John R. MacPherson Klotz; Treasurer, Henry M. Toch.

Dr. Homberger to Instruct at Louisville.

Dr. A. W. Homberger, head of the chemistry department of Wesleyan University, has resigned to take up his duties next fall as Dean of the chemistry department at the University of Louisville, Ky.

Atwater in Governmental Work.

Active duties as consulting engineer in connection with the Government nitrate plant of the Ordnance Department, U. S. A., are now taking the attention of C. G. Atwater, manager of the Agricultural Department of the Barrett Co., New York.

Industrial Filtration Papers.

The H. Reeve Angel Company have just launched the expansion of their filter papers department for manufacturing requirements. The Angel company have long been specialists in filtering materials, and the chemical engineer can consult them on his requirements with full confidence.

New Color and Chemical Plant.

Metro Color and Chemical Works has been incorporated with a capital of $75,000, to operate plant for the manufacture of chemicals and dyestuffs at Brooklyn, N. Y. The incorporators are A. Petersen, M. Goldhammer and R. Jensen, Brooklyn.

To Manufacture Chemicals.

With a capital of $500,000 the Brown Chemical Co. has been incorporated at Maplewood, N. J., to manufacture chemicals and allied specialties, by Oscar G. Brown, F. M. Brown, Maplewood, and Arthur C. Hamilton, West Orange, N. J.

McKerrow Vice-President of New Concern.

H. Gardner McKerrow, of E. F. Drew & Co., Inc., New York, to whose energy was chiefly due the uniting of the American dye industry, has been chosen vice-president of the recently incorporated Knickerbocker Dyestuff Co., New York.

Smith Returns to Permutit Co.

Albert Tate Smith, recently manager of the R. U. V. Co., manufacturers of ultra violet ray apparatus, has resigned to return to the Permutit Co., with which he was formerly associated, to act as assistant manager of sales.

Knickerbocker Dyestuff Co.

Capitalized at $10,000, the Knickerbocker Dyestuff Co. has been incorporated under the laws of New York to engage in the manufacture of dyestuffs, etc. The incorporators are M. Mackenzie, A. H. Gleason and J. J. Hayden, New York City. This company has already placed upon the market a new chrome brown described on another page of this issue. E. F. Drew & Co., Inc., are the agents.

Chemical Machinery and Equipment.

H. E. Jacoby has devoted a number of years to chemical machinery and equipment problems, and has developed a contact with various sources of supplies which enables him to get at equipment quickly. His experiences along these lines should be of value to departments contemplating expansion.

The Reed Laboratories
RESEARCH AND ANALYTICAL
SPECIALIZING IN LEATHER
TANNING AND DYEING MATERIAL
227 Fulton Street, New York, N. Y.

HELP WANTED

WANTED, ANALYTICAL CHEMIST FOR FERTILIZER FACTORY. A fine opportunity for an energetic and ambitious young chemist understanding machinery and with knowledge of heat engineering and practical chemistry. Write "V. C.," c/o Chemical Engineer.

C. L. PARKER
Chemical Patents
TRADE-MARKS
UNFAIR COMPETITION
McGill Building, Washington, D. C.

American Business—Attention!

The First of Every Month

will be observed as

Thrift Stamp Day
In The U. S. A.

The first Thrift Stamp Day went over big! It proved a tremendous boost for Uncle Sam's Thrift Stamps and War Savings Stamps campaign and for American business in general. As a result of the great success of the first Thrift Stamp Day, it has been decided to make the First Day of every month Thrift Stamp Day in the U. S. A.!

This means that every branch of American business has the unusual opportunity to make the first of every month a **red letter business day** throughout the Nation, and a **Victory day for the U. S. Government** by disposing of hundreds of thousands of dollars' worth of Thrift Stamps and War Savings Stamps!

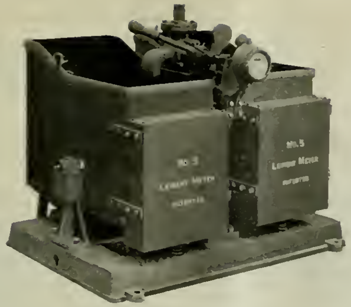
So get busy at once in preparation for these red letter business days these monthly Thrift Stamp Days! Manufacturers, jobbers, wholesalers, retailers, get together and plan for special Thrift Stamp Day sales, unusual values in every line of merchandise and commodity. It's up to you to help the Government and help yourselves at the same time.

Profit by your experiences of the first Thrift Stamp Day to make the succeeding Thrift Stamp Days still more of a success! Redouble the results! If any of you should still be unfamiliar with the working plan for Thrift Stamp Day, write for this plan **today without fail.** Address W. Ward Smith, National War Savings Committee, 51 Chambers St., New York City.

W.S.S.
WAR SAVINGS STAMPS
ISSUED BY THE
UNITED STATES
GOVERNMENT

NATIONAL WAR SAVINGS COMMITTEE
51 Chambers Street, New York City

W.S.S.
WAR SAVINGS STAMPS
ISSUED BY THE
UNITED STATES
GOVERNMENT



"MORE THAN A METER"

The Improved Leinert Automatic Liquid Gravity Scales

(PATENTED)

A Simple-Positive Mechanical Balance for Recording by Weight. Recommended for WATER—JUICES BRINE—CAUSTIC SOLUTIONS and LIQUIDS of all descriptions.

Not Affected by Temperature Changes or Variations in Specific Gravity. Special Scales to Meet Your Requirements. WRITE US YOUR SERVICE CONDITIONS.

JOHN SIMMONS COMPANY

107-111 Centre Street :: New York City

McCormack & Company

Chemists and Chemical ENGINEERS

Analytical and Consulting Chemists

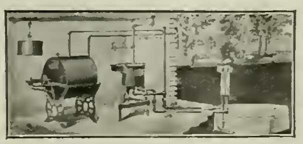
We enjoy making the unusual chemical analyses such as most chemists do not like to bother with.

We have at our disposal the best equipped laboratories in this country for the study of chemical manufacturing processes and problems.

OFFICE and LABORATORIES

33rd and Armour Avenue

CHICAGO Phone Douglas 390



GAS for Laboratory and Industrial Uses

Automatically and Cheaply Made by the

Detroit Combination Gas Machine

Over 30,000 in Daily Use

The Ideal Plant for Cooking, Lighting, etc., in Homes

Descriptive catalog and names of users in your locality sent on request.

DETROIT HEATING & LIGHTING CO.

616 Wight Street, Detroit, Mich.

Established 1868

H. A. METZ & CO., Inc.

122 HUDSON STREET, NEW YORK

BOSTON
PROVIDENCE
PHILADELPHIA
CHICAGO
SAN FRANCISCO
CHARLOTTE
ATLANTA

PRODUCTS:

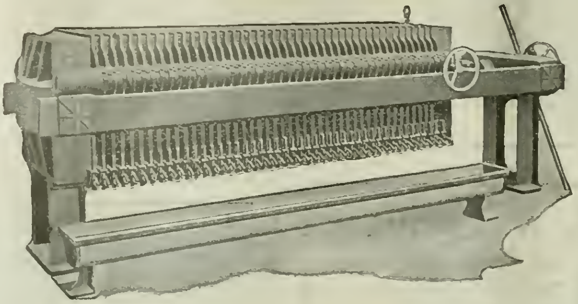
Dyestuffs, Colors, Intermediates, Sizing and Finishing Materials

Dyestuffs, Colors, Sizing and Finishing Materials Produced by Consolidated Color and Chemical Co. Newark, N. J.

Dyestuffs and Intermediates Produced by Central Dyestuff and Chemical Co. Newark, N. J.

Shriver Filter Presses

FOR ALL PURPOSES



SIDE FEED FILTER PRESS

FILTER PRESS PUMPS FILTER CLOTH AND PAPER

SEND FOR CATALOG "B"

T. SHRIVER & COMPANY

Office and Works: 812 Hamilton Street HARRISON, NEW JERSEY

WANTED

One complete set, bound volumes, of the CHEMICAL ENGINEER, Vols. 1 to 25, inclusive. Also send for list of back numbers wanted. Address Editor, 118 E. 28th St., New York City

BACK NUMBERS WANTED

The CHEMICAL ENGINEER desires to purchase back numbers as follows:

FEBRUARY-MARCH, 1917 AUGUST, 1917

Address Editor, 118 E. 28th Street, New York City

Our New Factory for the Manufacture of Pure Fused Silica, known as

SiDiO

has just been opened in New York City. A part of the output has already been assigned to the Government, but production is on such a scale as will enable us to meet your needs promptly.

SIDIO Ware is coming into wide use, both because of its low cost compared to platinum and other wares which it replaces, and also because of its technical superiority.

SIDIO withstands rapid temperature changes, it may be exposed to a continuous temperature of 1200° C. SIDIO has a coefficient of expansion one-seventeenth that of glass or platinum.

SIDIO is especially adapted for Combustion and Pyrometer Tubes, Sulphuric and Nitric Acid Condensing and Cooling Apparatus, high temperature gas analyses.

Chemical wares for the Laboratory made of pure fused silica, known as SIDIO, will give you added efficiency because of its low cost and technical superiority.

Get in touch with us at once so that you may benefit by the use of SIDIO Ware in your laboratory.

THE SIDIO COMPANY OF AMERICA, Inc.

37-39 MURRAY STREET, NEW YORK CITY

Cornered!

WE have no corner on Chemical Stoneware quality, yet we have it cornered—backed into a tight place where it can't get away from us—at bay.

In other words, we have put the kibosh on mere cost. The price you pay for General Ceramics ware is fair price, based on the very best Chemical Stoneware that anyone in all the world has ever been able to make.

That's what you get when you order G. C. Ware. You also get prompt action, and in case your order is large, you are enabled to draw upon the enormous facilities of our big plant.

General Ceramics Company

50 Church St., New York City

Western Sales Office: 112 W. Adams St., Chicago

See our exhibit at the Fourth National Exposition of Chemical Industries, Grand Central Palace, week of September 23rd.

Bring Us Your Dyestuff Problems

The application of dyestuffs to textiles is as important as their production. The technique of this branch of the color industry has for years commanded the best talent among those dyestuff distributors who have catered to the highest class of trade.

An intimate knowledge of the possibilities of every dyestuff is often necessary to meet the particular requirements of the consumer. Dyeing is a chemical, not a mechanical, process, and the variation of local conditions, due to differences in quality of water, steam and chemicals, makes the dyehouse problem an individual one.

Such problems are welcomed by the technical department of this company, which is manned by chemists who have been picked because of their knowledge, practical experience and demonstrated ability. We have long maintained well-equipped laboratories at our different offices for this purpose, and invite inquiries and extend, without any obligation on the part of our customers, our services to all who stand in need of them.

National Aniline and Chemical Company

INCORPORATED

21 Burling Slip, New York

THE CHEMICAL ENGINEER

VOL. XXVI. JULY, 1918 No. 8

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

LAURANCE T. CLARK,
Editor.
CHARLES B. DAVIS, F. C. S., Consulting Editor
H. C. DAYCH, Business Manager

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, JULY, 1918

Editorials—

Checkmate! 283
Government Mobilization of Technical Men.. 284
The Chemical Exposition—An Institution... 285
"Too Many Cooks . . . ?"........ 285
The Use of Gas........ 286
Waterproofing Textiles for Military Use........ 287
Herbert P. Pearson and Fred Sundermann, Jr.
The Recovery of Potash as a By-Product in the Manufacture of Portland Cement........ 289
John J. Porter.
Ultra Violet Light: Its Application in Chemical Arts. Part XV........ 291
Carlcton Ellis and A. A. Wells.
Fourth Chemical Exposition Will Show Progress 305
Coal-Tar Chemistry Section........ 307
The Manufacture of Naphthols........ 307
Copper Compounds of Ortho-Oxy-Azo Dyestuffs 309
German Patents on Coal-Tar Colors........ 309
An American Nomenclature for American Dyestuffs 310
Distillates: News Notes of Chemical and Allied Industries 316
New Publications 317
"The Mining and Concentration of Carnotite Ores" 317
The "American Fertilizer Handbook" for 1918 319

Checkmate!

Word has come from the western front that the Allies have discovered a new gas which neutralizes the effects of poisonous vapors employed by the Germans. According to the report, a barrage of shells filled with the new gas laid down in the sector flooded with the poison gas immediately purifies the atmosphere and renders the German clouds harmless.

This report has not been confirmed and does not state whether the new gas is effective against one, or two, or all of the fourteen-odd varieties of gases known to have been employed by the Hun in his efforts to make the world unsafe for democracy. Nor is it likely, in case it is true, that we shall hear much more about it, at least for some time to come, for it is necessarily the policy of the Government to exercise the most rigid form of censorship with respect to matters of this sort.

But assuming the truth of the report, then it becomes at once apparent that the effect upon the campaign in the western theatre of war will be most far-reaching. The Allies have long been retaliating in kind upon the Germans for their gas attacks, but consider the advantages of an army which is not only able to do this, but to render the enemy attacks fruitless!

Speaking of gas warfare, a member of the British mission to this country last winter declared that the chemists of both sides were working continuously to devise a colorless, odorless, and at the same time deadly gas. He stated that the side which first succeeded in doing this would almost certainly win the war. He also averred that the side which first compelled the other to adopt oxygen respirators as a defensive measure against gas attacks would practically drive their opponents out of the trenches.

Chlorine was the first gas used by the Germans, and within three days after the word had reached London, more than a million masks, made by the women of England, were on their way to the Allies' trenches. Other and still more deadly or irritating gases followed, and each time the Allies were able to develop suitable masks. Even the mustard gas, which caused men to vomit inside their helmets and rendered those affected virtually helpless before the Germans' subsequent charges, was at length overcome. When the enemy forsook the gas cloud for the gas-filled shell, the Allies again countered by adopting similar methods and issuing new orders about the wearing of masks continually while within certain zones. And so, at every stage of the struggle, the laboratories of both sides have been of vital importance and the chemists of the Allies have checkmated their opponents.

Defensive measures have kept pace with the offensive to such an extent that of late the best the Germans could hope for was to cause the Allies the inconvenience of wearing their masks while an attack was on—a situation which they were themselves in—or possibly to take the Allies unawares. If the present report is true, it would appear that their chemists now have by far the better of the battle of wits. The crowning achievement will come when someone of us devises a gas "invisible, odorless, and heavy enough to settle in the German trenches." It would save thousands of lives on both sides by ending the war almost immediately.

Government Mobilization of Technical Men

It is extremely gratifying to note that within the past month, two fresh evidences of an increased tendency on the part of the Government to watch over and supervise our chemical industries are reported. These evidences take the form of official announcements to the effect that the organization of the eagerly awaited "Chemical Warfare Service" has been completed, and that the War Industries Board has created two new divisions, to be known respectively as the "Chemicals Division," and the "Explosive Division."

The former organization will devote itself particularly to the control and development of all phases of gas warfare, and will be under the command of Maj. Gen. William L. Sibert. The two new divisions created by the War Industries Board will have under their official wings the production of the necessities indicated by their titles. Charles H. MacDowell, who was formerly chief of the "Chemical Section" of the Board, will be Director of the newly organized Chemicals Division, while M. F. Chase has been named to act as Director of the Explosives Division.

Newly drafted chemists will henceforth be immediately assigned to the Chemical Warfare Service, while all chemists now in the army will be removed from their units and placed under its authority. Some further idea of the scope of the new body can be gained by a perusal of Secretary Baker's announcement:

Heretofore chemical warfare has been carried on by divisions in the Medical Department, the Ordnance Department, and the Bureau of Mines. All officers and men who have been connected with offensive or defensive gas warfare here will be responsible to the Chemical Warfare Service. The field training section at present is under the Corps of Engineers.

Defensive warfare has been under the control of the Medical Department. This work has consisted of the designing and manufacture of masks both for men and animals and the procurement of appliances for clearing trenches and dugouts of gas.

Offensive gas warfare consists principally of manufacturing gases and filling gas shells. The work has been under the direction of the Ordance Department.

The new department will take over the work of chemical research for new gases and protection against known gases which has been carried on by the Bureau of Mines. All testing and experiment stations will be under the direction of the Chemical Warfare Service.

The responsibility of providing chemists for all branches of the Government and assisting in the procurement of chemists for industries essential to the success of the war and Government has been intrusted to the Chemical Warfare Service.

Authority to assign enlisted or commissioned chemists to establishments manufacturing for the Government has been granted to the new section.

The Chemicals Division will be subdivided into sections to handle the various commodities with which it is concerned, the chiefs of which will be as follows:

Acids and Chemicals—Albert R. Brucker, Russell S. Hubbard, and A. E. Wells.

Artificial and Vegetable Dyes—Dr. J. F. Schoellkopf, Jr.

Alkali and Chlorine—H. G. Carrell.

Asbestos, Chemical Glass, and Stoneware—Robert M. Torrence.

Coal Tar Products, (benzol, toluol, etc., including commandeering and allocation of toluol)—J. M. Morehead, Ira C. Darling, associate.

Rare Gases, Nitrogen and Oxygen—Chief not named.

Creosote—Ira C. Darling.

Electrodes and Abrasives—Henry C. Dubois.

Ethyl Alcohol, (molasses and grain)—William G. Woolfolk.

Ferro-alloys, (chrome, manganese, and tungsten ores)—Hugh W. Sanford, C. D. Tripp, J. H. McKenzie.

Fine Chemicals—A. G. Rosengarten.

Nitrates—Charles H. MacDowell, J. A. Bocker.

Paint and Pigment—Russell S. Hubbard.

Platinum—C. H. Conner, R. H. Carleton, G. I. DeNike.

Refractories—Charles Catlett.

Sulphur and Pyrites—William G. Woolfolk, A. E. Wells.

Tanning Material, (including inedible oils, fats, and waxes)—E. J. Haley, E. A. Prosser, Frank Whitney, Harold G. Wood.

Technical and Consulting—Dr. E. R. Weidlein, Dr. Herbert E. Moody, Dr. Thomas P. McCutcheon.

Wood Chemicals—C. H. Conner, A. H. Smith, R. D. Walker, Frank Whitney.

Statistics, Chemical (joint office)—Captain Willis B. Rice, army; Lieutenant M. R. Gordon, army; Assistant Paymaster Raymond P. Dunning, navy; Arthur Minnick, Chemicals Division.

A representative of the army, the navy, the Marine Corps, and other departments had been assigned to each section, and, with the Commodity Chief constitute the sections' membership.

In the Explosive Division, Mr. Chase co-ordinates with representatives of the army, the navy, and other departments concerned, and consults with the various section chiefs of the Chemicals Division.

The Chemical Exposition—An Institution

No longer is it necessary to explain why chemical expositions are beneficial, not alone to technical men and all others immediately concerned, but to the country at large. No longer is it necessary to paw the air for adjectives calculated to inspire the vacillating ones to "make up their minds to attend (or exhibit) and hang the expense!"

"Ballyhoo" methods were all very well in their place, which was the old-fashioned county fair where the guileless but extremely cautious rustic required considerable wheedling before he would consent to step up and point out just which shell the little green pea *wasn't* under, or, perhaps, part with a dime in order to feast his eyes upon the tattooed man, bearded lady, living skeleton, et al.

Were P. T. Barnum alive today he would discover that his public no longer delighted in being "fooled." A change has taken place, due in large measure to the sobering effect of a world-wide and bloody struggle for freedom from oppression, which would doubtless cause the great showman to blink his eyes. And for this reason educational events of the character of the National Exposition of Chemical Industries, the fourth of which is rapidly approaching, have now become as much of an institution with us as our elections, taxes or daily papers.

This year will see but two classes of the chemical fraternity contemplating the forthcoming event at the Grand Central Palace, New York City—those who are going, and those who are prevented from going by Government work. And among the potential exhibitors will be those who have booths and those who failed to make application in time. There is no indecision to overcome, we take it; there are no heathen to convert, and hence any eloquence which might otherwise have been employed for this purpose will be saved for the advent of the Fourth Liberty Loan.

The permanent slogan adopted by the managers: "Expositions are the timekeepers of progress," has taken on an added significance for us since it was first uttered by President McKinley. And the progress of our chemical industries during the past year, when graphically demonstrated in its entirety next September, will, we venture, be something to startle even those who have been in close touch with one or more phases of it.

The motion picture and conference hall will be located at the extreme rear of the third floor. Close to the entrance, as was the case last year, The Chemical Engineer will have a reception booth at which we hope to welcome many of our friends who seized the opportunity to pay their respects in person at the exposition of 1917. All visitors to the show are cordially invited to make this booth their headquarters and are hereby assured of a hearty welcome, together with whatever services or information it may be within our power to furnish.

The program of motion pictures to be presented is expected to furnish several surprises, although it is not yet in final shape for a detailed announcement. However, it is rumored that one or two of the largest exhibitors are laying plans for several unusual "stunts" in the shape of films especially prepared for first run at the exposition. These are said to be quite out of the ordinary. Specific subjects to be dealt with in the general motion picture program, the titles of which are to be announced later, will be Potash, General Chemical Engineering, Acids, including nitric and sulphuric; the Ceramic industries, and possibly the Metal industries. Special groups of films will also be shown, taking up in detail such subjects as recent progress in the development and application of our water-power, carelessness in the industries, with its attendant destruction of life, wealth and resources; recent progress in the oil industries, etc.

Altogether, the forthcoming Chemical Exposition bids fair to become a worthy offspring of its forbears of preceding years, and to offer a true index of the steady march of progress.

"Too Many Cooks . . . ?"

Do they? Some years ago the late John Jacob Astor advanced the opinion that should any technical achievement within the limits of physical or chemical laws, as we understand the terms, suddenly become of supreme importance to the welfare of the human race, a sufficiently large number of our scientists had only to devote their united abilities to it, and its accomplishment was assured.

The propounder of the above evidently took little stock in the saying that "too many cooks spoil the broth." He believed the reverse to be true, and was at some pains to point out the vast number of inventions which had germinated and languished for years in the brains of individuals, and which had refused to sprout further until some accident or sudden need turned the attention of many to the problem.

The present war has seen this principle beautifully illustrated again and again, and after the white flag has been hung out at one of the windows in a certain Palace in the Wilhelmstrasse, it is to be hoped that its role in speeding up the progress of the world will be even more fully understood. A contemplation of history repeals how surprisingly few of the truly epochal scientific achievements—by which is *not* meant "discoveries"—are the products of any one mind. Also, it appears to be true that the length of time consumed in working out such achievements varies, as a rule, inversely with the number of minds at work upon them.

Another example has just been added to the list. In these days, when one accomplishment follows upon the heels of another so rapidly as to almost bewilder the student of affairs, it will attract little or no attention. And indeed, it is not in itself a marvel at all; it serves rather to illustrate the rapidity with which a battery of trained minds, not one of which is necessarily a genius, as opposed to the old-fashioned "inventor," can develop new combinations of the elements to fill suddenly created wants. Not so many months ago the problem just solved by co-operative effort did not exist, and even the possibility that it might exist had never occurred save, likely, as mere idle speculation on the part of a very few.

Announcement has been made that the concrete ships being constructed by the Emergency Fleet Corporation will now come more directly into competition with steel ships as the result of the evolution of a novel protective coating, according to R. J. Wig, chief engineer of the Concrete Ship Division of the corporation. The nature of the new coating must, of course, be kept secret, but its evolution has resulted from the combined efforts of the engineers who are devoting their entire time and energies to perfecting this type of vessel.

In a statement regarding the new discovery, Mr. Wig said recently: "From our comprehensive tests of concrete structures at seawater we are assured that concrete ships will last a minimum of several years without any protection whatever. By the application of protective coatings, which are well known to us, we are certain of an extended life of several years additional, and with the further development of protective means upon which we are now working, I believe the concrete ship can be made as permanent as steel, if not more so."

Mr. Wig's earnest desire to quash immediately a false rumor now current regarding the life of concrete ships, will be shared by all who are alive to the harm which inevitably follows any addition to the already overwhelming maze of contradictions and inaccuracies which breed distruct in the abilities of those who direct our war industries. He states that: "At a meeting of the American Concrete Institute, held recently at Atlantic City, I was unfortunately misquoted as saying that the concrete ship would last only one year. Of course, this is not so nor did I say it, and I am anxious to have this erroneous statement corrected as soon as possible, because it puts the concrete ship in an utterly false position.

"The many able engineers who are now devoting their time to the study of concrete in our own organization are becoming more and more enthusiastic over the future of concrete ships. Improvements are constantly being made which make concrete more suitable for shipbuilding.

"Few people realize that the concrete ship is actually 20 per cent. lighter than the wood ship, if built of a new concrete mixture developed by the Emergency Fleet Corporation. The aggregate from which this new concrete is made is so light that it floats on water, and yet it makes a kind of concrete possessing twice the strength of that used in ordinary building construction. With this development, the concrete ship will come into more direct competition with the steel ship.

There are many problems yet to be solved in the building of concrete ships, and while this new industry sprung into life as an emergency war measure, its future is becoming more and more established as a permanent institution."

And to this, without question, will be added many others born of stern necessity and the focussing of many minds upon a given problem. The lesson is plain, and may profitably be applied here after the present stimulus is a thing of the past. How much longer might the need referred to have gone unfilled with only one or two men working—and independently of each other, at that—to devise a solution? Germany early learned the virtues of the plan and we marvelled at her results. Persistently applied among us, and aided by proverbial Yankee ingenuity, the possibilities of the future are scarcely to be measured by terms that we could have understood a short decade ago.

The Use of Gas

For Laboratories, Isolated Factories, Homes and Stores. Its Advantages in Heating, Cooking and Lighting.

By William A. Charters.

There is nothing that excels gas for use in the laboratories of factories for operating Bunsen burners, sterilizers, warming closets, auto claves, blast furnaces, forges, incubators, heating and lighting.

Concerns having laboratories or factories and people living out of reach of the public service gas mains and who, therefore, consider gas as altogether beyond their reach and something that they could only wish for yet never obtain, will be interested in the Equalizing gas machine manufactured by the Tirrill Gas Machine Lighting Co., 103 Park avenue, New York City.

For over fifty years this company has been manufacturing their gas machines, burners and appliances for some of the best known and critical concerns in the country, such as the U. S. Dept. of Agriculture, Bureau of Soils, Dept. of Chemistry, West Point, N. Y.; Agricultural Experiment Station, Mayagnez, Porto Rico; Dr. W. S. Wiley, Analytical and Consulting Engineer; A. H. Smith, president N. Y. C. & H. R. R.; Du Pont Powder Co., Atlas Powder Co., Government Base Hospital, U. S. Navy Yards; Procter & Gamble Mfg. Co.;

(*Concluded on page 306.*)

WATERPROOFING TEXTILES FOR MILITARY USE

By HERBERT P. PEARSON and FRED. SUNDERMANN, JR.[*]

Misconception regarding the term waterproofing and the waterproofing industry is responsible for two unfortunate facts. The United States soldier is clothed in materials which absorb water nearly as easily as the paper you blot your signature with and the Textile Industry in general is ignoring the resistance to such absorption as an important factor in the Conservation of Wool.

The reason for this condition of affairs is that the minds of nearly all army officials and of some textile experts are clouded with the idea that to make a fabric water-resistant is to waterproof it and that to waterproof it, is to close up its pores and change its appearance and other properties.

They are right about the effects of waterproofing because, as the dictionary tells us, a waterproofed fabric is one that is impervious to water, and you can't make a textile fabric impervious without closing up the *holes* that are in it,—that is to say, the spaces between the fibres.

Even the company we have the honor to represent has not as yet succeeded in making a hole impervious to water!

Where the responsible parties go wrong—and it sometimes takes thirty minutes personal lecturing to make them see that they *may* be wrong—is in assuming that a fabric cannot be benefited in the direction of waterproofing without being waterproofed.

We propose to demonstrate how without change of appearance or filling up of pores, the woolen fabrics used in army uniforms and overcoats are being successfully processed to make them much less absorbent, much quicker to dry when wetted, and possess much better wearing quality, by the simple means of treating the fabric in order to lower the surface tension of the fibres as compared with that of water.

To these processes we are attaching the name "water-resisting" and to the fabrics processed the term "water-resistant" to distinguish them from waterproofing processes and impervious fabrics.

Right here it would be well to state that many wearers of raincoats made of fabrics, the pores of which are not closed, are deceived by the terms "shower-proof" and "rain-proof" under which they are sold.

A shower is rain anyway, and rain is water, which, if pressed hard enough into the fabric by the weight of the rain drops accompanied by the driving of the wind, will go through any porous fabric if the pressure is great enough to overcome its surface tension, even though it be lowered by a water-resisting process.

Even a raincoat made of rubberized fabrics is apt to let water through under the higher pressures induced by extreme weather if the rubberizing does not completely close the pores, or if the seams are not heavily enough cemented.

A more general understanding is necessary, therefore, of this simple law:—

The degree of resistance of a fibre to water is determined by the greatness of the difference between the surface tensions of the fibre and that of water, and by the force with which the water is applied to the fabric, perfect imperviousness being produced only by entirely closing the spaces between the fibres.

What then, may be asked, is the good of a water-resisting process on a fabric if it is not impervious under all conditions?

Without altering the appearance or adaptability of most textile fabrics the fibres can be impregnated with substances which lower their surface tension to water so much that they are quite difficult to wet and when wet, dry out very quickly owing to the lack of thorough wetting through of the fibres under ordinary adverse weather conditions.

This resistance to wetting is not all the effect that can be produced by this means, for with a fabric of suitable character a considerable resistance to the *penetration* of water can be procured.

A textile fabric may be said to consist of a surface full of holes of greater or less size. If the fabric be treated with a water-resisting process and water applied, the surface of the water covering these holes acquires a convex form. This convexity is sufficient to enable the surface tension of the water to resist the inward pressure of the water against the fabric. If the pressure be increased sufficiently, the radius of curvature will become less than the radius of the holes; the water will go through, and it will keep on going through so long as the pressure is maintained.

It is needless, therefore, to point out that to resist the great pressure of a large drop and prevent its penetration, the fabric must have as few and as small holes or pores in it as possible, and the water-resisting treatment must be such as to secure the greatest difference between the surface tension of the water and that of the treated fibre.

Thus, if the fabric is of the right kind and the water-resistance effectual, a garment may be made of it which will keep out rain to a very considerable degree. If the water-resistant fabric is of open weave, the pressure of a rain drop will cause it to go right through, but the fabric itself will not become wet either immediately or readily. To wet the fabric the tiny pores of the fibres themselves have to be penetrated, and this requires greater force than the mere pressure of ordinary rain drops. Open-weave fabrics of this sort can be produced which can only be thoroughly wet by applying repeated blows to water laid on the surface of the fabric or by dabbing repeatedly with a wet object.

---

[*] Respectively General Manager and Works Manager, The Cravenette Co., New York City. Presented before a meeting of the New York Section, American Chemical Society.

We know from the experience of many not strictly comparative wearing tests that this resistance to wetting increases the life of the fabric considerably, and we are at present conducting a series of wearing tests to demonstrate this beyond doubt and to arrive with some degree of accuracy at the extent of the increased wearing quality.

We have a number of woolen suits, some untreated and others made water-resistant, undergoing a comparative test in ordinary wear and the Quartermaster's Office of the War Department has given instructions for a comparative test of wool uniforms and overcoats. This latter is to be done by clothing a platoon of men with water-resisting coats and uniforms and another with garments made of the same cloth untreated.

Apart from our experiences, the theory of the lengthened life of the treated fabric is that the wool fibre on becoming wet changes its curl and on drying again resumed to a great extent its former state. This causes a movement in the fabric and a loosening of the yarns, which tends to weaken their resistance to friction, for it is common knowledge that a tightly-twisted yarn wears better than one of looser character.

We have made numerous tests of the reduction in the absorption power of wool and cotton by exposing samples to a shower with a thirty foot drop, hanging to drain and observing the increased weight and then the rate of drying. The following figures give some of the results obtained on wool fabrics. The drying referred to consisted of hanging for one hour in a warm room:—

A heavy mackinaw cloth, untreated, under a very heavy test absorbed 141% of water against 25% when treated, and after drying contained 101% against 9% when treated.

A heavy army overcoating under a light test absorbed 38% of water against 15% treated, and after drying contained 12% against 3% treated.

A thick, grey all-wool flannel under a heavy test absorbed 140% against 60% treated, and after drying contained 104% against 32% treated.

We estimate from these observations that a soldier caught in a winter downpour of rain is soon carrying about with him in his overcoat no less than 7 pounds of water, whereas if the fabric is made water-resistant the most he is likely to carry is three pounds, and it is obvious that this saving of weight means a great deal when on the march.

The processes through which fabrics are put to make them water-resistant are not expensive. They add less than 1% to the cost of a garment and even if they only increase the life of the garment 10%, there is a very obvious saving in dollars and cents at the end of a period during which old garments have been exchanged for new.

The resistance to wetting of a solid substance depends on the extent of the difference between the surface tension of the substance and that of the wetting liquid. The greater the difference the greater the resistance. Consequently in making fibres resist wetting it is necessary to treat them with substances having as low a surface tension as possible.

The object of the water-resister, as distinguished from the water-proofer, is to impregnate the fabric and the fibre of the fabric with such a substance, taking care that the substance has as high a melting point as possible in order to avoid the shifting of the protecting body under the influence of the sun. It is also necessary, and quite an expert task, to eliminate from the fabric beforehand any substance which might mix with the water-resisting agent and thus raise its surface tension.

In conversation with a member of your society the point was brought out by him that if all the American army uniforms had been made water-resistant, many a case of pneumonia among the soldiers might have been avoided.

While this may be somewhat exaggerated, it is, nevertheless, certain that to make it much less easy for a uniform to get wet and much easier for it to dry when wet, is to contribute to the health and efficiency of the soldier.

We submit therefore that it is in the interest both of military economy and efficiency, and of the Conservation of Wool, for every yard of wool fabric made up into every kind of garment during the war, to be subjected to a thorough and expert water-resisting process, and we shall be grateful for any assistance which will enable us to secure action in this direction from the responsible authorities.

Finally we may say that our company is willing to cooperate with the Government in every possible way with this end in view.

Leases H_2SO_4 Plant.

W. Gordon McCabe, of Charleston, N. C., has leased the sulphuric acid plant of the Independence Chemical Co., of Charlotte, N. C.

Two More Government Nitrate Plants.

Contracts for the construction of two plants for the manufacture of nitrates from the air, to be located at Elizabethtown, Ohio, and Toledo, Ohio, respectively, have been awarded by the Nitrate Division, Bureau of Ordnance, U. S. War Dept., to the Air Nitrate Corp., Madison Ave., New York City. The cost of the two will run into several million of dollars.

THE RECOVERY OF POTASH

As a By-Product in the Manufacture of Portland Cement

By
JOHN J. PORTER *

Prior to the war over 1,000,000 tons per year of potash salts were used in this country. This is equivalent to approximately 300,000 tons of pure potash and represents a value of about $18,000,000. There is every prospect that this consumption will be largely increased when a full supply of potash is again available.

Over 90 per cent. of our normal consumption of potash is used as fertilizer. Potash is one of the three elements essential to plant growth. It is present in small quantities in all soils and we can get along for a while on these reserves. Since it is removed from the soils by crops, however, it must be replaced and in the long run must be added. There is no substitute for this purpose.

Potash is also used in the form of pure salts in various chemical industries. The quantity required is not very large but it is very necessary, as in many cases no substitute is admissible.

For many years the world's supply of potash has come from natural deposits located near Stassfurt, Germany. It occurs there in beds associated with rock salt and gypsum and can be mined very cheaply. The German potash industry is controlled by the Government and all producers are required to sell through a syndicate whose policy has been to stifle competition in other countries by temporarily cutting prices. This they have been able to do because of their world market and low cost of production.

Cement Industry as Source of Potash.

With the outbreak of war, the world's supply of potash was at once cut off and the operation of many industries badly dislocated. In spite of the spur of high prices, the output of potash in this country in 1916 was less than 5 per cent. of its normal consumption and the majority of present producers can only continue to operate so long as prices remain at or near their present levels. It is probable that the cement industry, certain brine lakes and alunite will remain as permanent producers but their output as at present developed is only a drop in the bucket. Extensive explorations have not succeeded in locating anything similar to the German deposits in this country. Small deposits have been found in Spain and Abyssinia but considering the situation broadly, there is absolutely no relief in sight from the German potash monopoly unless it be through the co-operation of the cement industry.

The cement industry is undoubtedly the chief potential American source of potash, especially when considered in connection with the use of feldspar and other high potash materials. Based on available information, I estimate that the mills of this country, as at present operated, are capable of producing commercially about 100,000 tons per year of potash or about 33 per cent. of our normal requirements. The possibilities through the use of high potash materials are much greater.

All cement materials contain some potash. As a rule the purer limestones contain very little, say from 0.1% to 0.3% and from there running up to 1% and over in the argillaceous limestones. Many clays and shales contain as high as 3% and 4% potash.

In the raw mix as fed to the kilns, the potash varies from about .30% to 1.30% in the various mills of the country. Probably the average for the whole country will not be far from .75%; a small percentage to be sure, but equivalent, nevertheless, to 4.5 lbs. of potash entering the kilns for every barrel of clinker made or to 220,000 tons per year.

The profitable recovery of this potash is not simply the problem of collection but rather the problem of obtaining it in a sufficiently concentrated form to be salable and at a sufficiently low cost to leave a profit under normal market conditions. The three factors to be considered in this connection are first, liberation; second, recombination, and third, collection.

The potash in the raw mix remains partly in the clinker and in part is volatilized or liberated in the kilns and passes out with the stack gases. The percentage of the total potash so liberated varies in different mills and under different conditions from 25% to 95%. The average under usual operating conditions is probably about 50%. Our liberation at Security was originally about 40% but by various changes, we have increased it up to a present average of over 60% and for several weekly periods have obtained as high as 70%.

Problem of Liberation.

We have still much to learn regarding liberation but there is evidence so far that it can be increased by high lime, hard burning and by the addition of chlorides or fluorides to the raw mix. The use of calcium fluoride or fluorspar has been patented by Messrs. Huber and Reath and is in use at the plant of the Riverside Portland Cement Co. At Security we have developed the use of common salt (sodium chloride) for this purpose and by its use have greatly increased our liberation. I understand that a Western mill which is getting in regular operation 95% liberation is using a raw mix

---

*First Vice-Pres. and General Manager, Security Cement and Lime Co. Paper presented at a meeting of the Portland Cement Association.

containing naturally about 5% salt. If this is true, their high liberation is readily explained.

When we undertook the collection of potash we expected that practically all of our potash would be in a water soluble form. This expectation was based on the results obtained at Riverside where the Cottrell dust collection system had for some time been in operation. Naturally we were much disappointed after starting up our plant to find that the material collected contained a considerable proportion of potash in a form which was not readily soluble in water. As under trade customs prevailing in the fertilizer industry, we could not secure payment for this portion of the potash, it made a big difference in our profits and the matter was, therefore, most thoroughly investigated. We found that the trouble was due to the recombination of a portion of the volatilized potash with the finely divided ash of the coal as this floated through the back part of the kiln. This ash takes up potash vapor until it reaches a certain degree of saturation and the amount of potash so recombined is, therefore, roughly proportional to the amount of coal ash present in the gases. The amount of potash recombined will be approximately 10% of the weight of the ash present, or for our conditions as to fuel consumption and quality of coal, will be from .8 to .9 lb. of potash per bbl. of clinker.

I should explain that at Riverside, oil is used as fuel so that, in spite of the work done there, the real nature of the problem and the difficulties introduced through the use of coal as fuel were not fully understood when the Security Company started in the potash business.

Solubility of Potash.

Further work on this problem developed the fact that this recombined potash was not insoluble in water but was only very slowly soluble. It will all go into solution on boiling for 10 hours or by heating with water under 100 lbs. pressure for one hour. It is also different from the potash as contained in the original mix by being readily soluble in very dilute acids. It is, therefore, entirely possible to leach all of the recombined potash from the material collected.

Many methods have been tried for the purpose of preventing the recombination of the potash in the back part of the kilns, and our chemists, Messrs. Haff and Cheesman, have applied for a patent covering the use of salt in that connection. We have found it possible to considerably lessen the amount of recombination, but so far we have not been able to entirely eliminate it.

Electrical Precipitation Effective.

At Security we have made use of the Cottrell electrical precipitation method for the collection of our potash. Personally, I believe that this method is the best system, but I would not claim that it is the only possible method of collection. I have no first hand knowledge of the various water spray methods which have been advocated but I should expect that there would be some difficulty in getting a high percentage of collection with this type of apparatus.

We have found the Cottrell system highly satisfactory from an operating standpoint. The cost of operation has been low and it has given practically no trouble. Originally we caught about 95% of the dust and about 80% of the potash going to the treaters. Since we have been adding salt, however, we have not done so well on collection. It has been found that the presence of chlorine in the gases causes a considerable decrease in the electrical efficiency of the treater, but, nevertheless, we have found it very profitable to continue the use of salt because the increase in liberation has much more than counterbalanced the decrease in collection efficiency.

I might as well admit frankly that we have suffered the usual penalty of pioneers and have not gotten the best type of treater from the standpoint of potash collection. At the time our plans were made all treaters had been designed from the standpoint of dust collection and the importance of obtaining the potash in a concentrated form has not been developed. The Western Precipitation Company, owners of the Cottrell patents, and ourselves are now engaged in developing, and, in fact, installing at Security a new type of treater adapted particularly to the collection of potash. This type of treater can be built almost entirely of concrete or brick at a considerable saving in cost. It will operate on the principle of having a film of water flowing over the precipitating surface so that the material will be recovered in form of solution and slurry. It has been found that in the presence of a water film the difficulty due to the presence of chlorine or chlorides in the gases is entirely overcome and a very high efficiency of collection can be obtained. The water will be circulated through the treater until it becomes saturated with potash salts and these will then be recovered by a process of evaporation and crystallization.

The gravest error in the construction of our treater, however, was to precipitate all the dust and potash together in one hopper. It would have been just as easy to have arranged the treater on the principle of the original late treaters at Riverside. The dust could have been precipitated selectively, recovering the coarse dust containing but little of the potash in the first chamber and a concentrated potash material in subsequent chambers. This procedure would make the sale of the potash material vastly easier.

The quality of the material collected is inversely as its quantity. There is practically a fixed amount of potash caught per day and this is diluted with whatever raw mix is blown over from the kilns. It is extremely desirable from a sales standpoint to collect a high potash material and therefore, to keep down the amount of dust blown over or else to precipitate out the coarse dust first as suggested above. At Security our dust loss averages about 4% and I should judge that for the average cement plant, it will run close to 5%. The percentage of potash in our material as col-

(Continued on page 312)

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By CARLETON ELLIS and A. A. WELLS[*]

PART XV

Mercury Lamps for Use in Spectroscopy, Polarimetry, and Saccharimetry.

The use of the mercury lamp in spectroscopy, polarimetry and saccharimetry is advocated by *Lowry* (Trans. Faraday Soc., 1912, *7*, 267). In spectroscopy no great intensity of light is needed, the light emitted from a vacuum tube being quite sufficient for taking readings with a spectroscope or with an instrument such as the Pulfrich refractometer. A mercury light of sufficient intensity for this work, Lowry states, can be produced very conveniently from a hydrogen tube containing a globule of the metal; this hydrogen-mercury tube has the advantage that it lights more easily than a tube containing mercury only, while by warming the globule, the spectrum of the metal can be made as bright as may be wished.

The problem of providing a source of light for use in polarimetry, he considers, much more difficult, on account of the fact that the intensity of the light is reduced to a small fraction of its original magnitude by the action of the Nicol prisms. The polarizing Nicol begins by eliminating half the light, and if the half-shadow angle of the instrument is set to 5° there is a further reduction to $\sin 2\frac{1}{2}° \times \frac{1}{2} = 0.0218$ at the "extinction" position. The intense light of the modern mercury lamp renders it exceptionally suitable for use in polarimetry, and it is now beginning to be employed to a considerable extent also in technical saccharimetry.

The chief advantages of the mercury light may be summarized as follows:[1]

1. The green line is of exceptional purity; a rotatory power of 5,000° can be read as easily as one of 5°; on the other hand, when sodium is used, the two lines, D_1 and D_2 do not extinguish together except in the case of small rotations.

2. The line can easily be separated from the other constituents of the spectrum by means of a direct vision prism of low power; no extra cost is involved in fitting this to the eyepiece of the polarimeter, as even sodium light cannot be used for accurate work unless some such method is used to purify the crude flame-spectrum.

3. On account of the great intensity of the light the half-shadow angle of the polarimeter may be reduced to 2°, 1° or less; the instrument then becomes exceedingly sensitive. Alternatively, cloudy or colored sugar syrups may be read with a half-shadow angle of moderate size.

4. The light is absolutely steady and may be kept running without interruption for a week at a time; all risk of change of zero through changed illumination is thereby avoided.

5. Contamination of the atmosphere and dirtying of the instrument by sodium salts are avoided.

6. The readings are usually at least 18 per cent. greater for mercury green than for sodium yellow light.

The credit of introducing the use of the mercury lamp in polarimetry, according to Lowry, belongs to Disch[*] and to Schönrock,[†] who made use of the Arons lamp. In 1906 Lowry introduced this method of illumination in his own laboratory; since that date the sodium light has been abolished, except when dispersion values are required, or when some comparison has to be made with observations made by the older methods. He states that mercury lamp is also being used at South Kensington and at Cambridge, and, when its advantages have been generally realized, will certainly be adopted as the ordinary method of illumination.

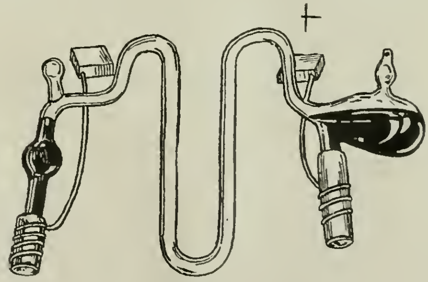


Fig. 1—The Bastian Glass Mercury Lamp.

Although no longer on the market, the Bastian glass mercury lamp (Fig. *1*) he regards the best for ordinary laboratory use. Its current consumption is small; no auxiliary resistances are required; the flex carrying the current to the lamp can be plugged into the ordinary lighting circuit without damaging the wires or blowing the fuses; and for work of high accuracy the light is found to be purer, and the continuous background to the spectrum far less intense, than in the case of the silica lamps of high power which have displaced it from commercial use. The lamp must be lighted, and is intended to burn with the zig-zag tube in a horizontal plane; but as soon as the tube is hot the lamp may be turned into a vertical plane and will burn in this position for some days without going out. It is then possible to focus one of the straight portions of the tube upon a vertical slit, thus producing an intense and uniform linear illumination.

---

[*] All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

[1] Compare *Phil. Mag.*, 1909, 22, 320-327, where the use of mercury and cadmium lines as standards in refractometry has been advocated.

[*] *Ann. Phys.*, 1903 [iv.] 12, 1155.

[†] *Z. Vereins Deutsch. Zucker, Ind.*, 1903, 53, 652.

Two forms of silica lamp have been designed for use with the polarimeter. The lamp shown in *Fig. 2* was designed in order to use the arc in the end-on position. In a lamp of this type the bulb on the right in the figure usually becomes covered with drops of condensed mercury; to avoid this a window of polished silica was mounted on a re-entrant tube in the center of the bulb where it is kept hot by the arc and remains clear and free from globules of mercury. The lamp takes a current of 3½ amperes and produces a very powerful light. It was found to be of very great service in taking polarimeter readings with the violet mercury line, when studying rotatory dispersion, the violet light being so intense that readings can be taken with a half-shadow angle of about 4° only.

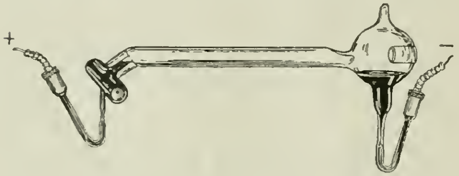


Fig. 2—Silica Lamp for Use in Polarimetry.

The chief disadvantage of the end-on lamp is that a slight displacement of the lamp may produce a marked alteration in the relative illuminations of different parts of the field of the polarimeter. The lamp must therefore be set very carefully if a constant zero-reading is to be maintained. This difficulty can be avoided by using a horizontal line of light to illuminate the polarimeter when the field is divided vertically, or a vertical line of light for a polarimeter in which the divisions are horizontal. Most of the commercial silica mercury lamps are arranged with a horizontal arc, and are therefore not suitable for use with aspectro-polarimeter in which the division of the field must be made horizontal. In order to overcome this difficulty the lamp shown in *Fig. 3* was devised. It is a modification of the commercial "Quartzlite" lamp and was constructed specially by the Brush Electrical Engineering Company for use in the vertical position. Two of the lamps used by Lowry for nearly a year and proved to be satisfactory in every respect. The line of light is very intense as the arc "pinches" into a narrow column (about ⅛-in. diameter) in the center of the tube. The only drawback to this concentration is the development of an appreciable quantity of continuous light, and a marked intensification of the weaker lines, demanding some additional care in the spectral purification of the yellow and violet lines.

Carbon Monoxide.

Berthelot and *Gaudechon* (Compt. rend., 1913, *157*, 129), have shown the aptitude of carbon monoxide to form additive products by its behavior towards certain gases under the influence of ultra violet light. In the presence of nitric oxide, a small proportion of the carbon monoxide is oxidized by the oxygen set free from the decomposition of the nitric oxide. With water the reaction is more complex, one part of the carbon monoxide combining directly with the water, yielding formic acid, while the rest combines with the hydrogen and oxygen, resulting from the dissociation of the water to give formaldehyde and carbon dioxide respectively. Of the halogens chlorine combines with carbon monoxide but bromine and iodine are without action. While combining with ammonia, chlorine is without action on hydrogen phosphide or arsenide, and does not react with hydrogen sulphide or free sulphur.

Decomposition of Carbon Dioxide.

The combination of carbon monoxide with oxygen in ultra violet light is found by *Herchefinkel* (Compt. rend., 1909, *149*, 395) to be reversible, considerable quantities of carbon monoxide being formed when dry carbon dioxide is exposed in quartz vessels, in the presence of mercury, to the action of the light. He confirms Cameron and Ramsay's observation that this decomposition is also effected radium emanation (J. Chem. Soc., Trans., 1908, *93*, 981).

Sulphur.

The manner in which the electrical conductivity of sulphur changes with the temperature varies according as the sulphur is crystalline or amorphous. The conductivity of crystalline sulphur increases with rise of temperature to a maximum at about 140-150°, and afterwards continues to fall until the boiling point is reached. With amorphous sulphur the conductivity falls as far as 140-150°, then increases up to 160-170°, after which temperature it falls continuously to the boiling point. With amorphous, but not with crystalline, sulphur the conductivity is increased by the action of light, this effect being caused more especially by rays of shorter wave-length than 280 $\mu\mu$. This phenomenon is conditioned by changes occurring in the sulphur, and by phenomena such as that of Hallwachs. (*Pigulewsky*, J. Russ. Phys. Chem. Soc., 1912, 44, Phys. Part, 102; J. Chem. Soc., 1912, Abs. 102, ii, 418.)

Colloidal Metals.

Commenting further on the formation of disperse systems by metals under the influence of ultra violet light and Rontgen rays, *Svedberg* (Zeitsch. Chem. Ind. Kolloide, 1910, 6, 129) states that the effect is greatly diminished if the active metals are superficially exodized. The quantity of the colloidal metal formed is proportional to the amount of radiation which falls on the surface of the metal. The mean size of the colloidal particles increases with increase in the time of exposure to the active rays; this is said to be due to an aggregation of the very small particles, which are formed primarily, under the influence of active radiation. The formation of the colloidal metal is unchanged when the metal is electrically charged. For a given metal the magnitude of the disintegrating effect is dependent on the nature of the dispersive medium in which the metal is immersed. It is much greater for ethyl alcohol than for ethyl ether. An exact comparison of the behavior of different media is, however, rendered difficult by the fact that these absorb the ultra violet rays to very different extents.

An examination of the dependence of the effect on the wave-length of the incident radiation indicates that colloidal formation is not produced to any sensible extent by rays of wave-lengths greater than about 405 to 410 $\mu\mu$. The phenomena are supposed to be due to the solvent action of the liquid on the metal, whereby small quantities of a chemical compound are found; under the influence of the ultra violet or Roentgen rays, this compound is decomposed, and the metal separated in the colloidal form. In support of this explanation, experiments are described which show that similar colloidal solutions are obtained when disks of the active metals are suspended immediately above the surface of the dispersive liquids and subjected to the action of the rays from a quartz mercury lamp. With lead and ethyl alcohol, the formation of a colloidal solution can be detected at the end of fifteen minutes. Svedberg supposes that the metal is acted on by the alcohol vapor and that the resulting compound dissolves in the liquid.

Action of Ultra Violet Light on Colloidal Gold.

Svedberg (Zeitsch. Chem. Ind. Kolloide, 1910, 6, 238) describes experiments which show that ultra violet rays have a considerable influence on the nature of the colloidal gold which is obtained by the action of reducing agents on solutions of gold salts. If a solution of chloroauric acid is made alkaline and reduced by means of hydrazine hydrochloride in the presence and absence of ultra violet rays, the colloidal gold which is obtained consists of very much smaller particles in the former case. The change in the character of the solution which is brought about by the ultra violet radiation disappears very slowly when the solution is kept in the dark before the reducing agent is added. Attention is called to the importance of these observations in connection with photo-chemistry.

Mercury.

The phosphorescence of mercury vapor has been observed by *Phillips* (Proc. Roy. Soc., 1913, A, 89, 39) by directing a beam of light λ = 2536 from water-cooled quartz mercury lamp on to an exhausted quartz tube, in which a stream of mercury vapor is produced by distilling mercury from one limb into the other. The mercury fluoresces at low pressures, and persists after the vapour has passed the exciting beam of light. The fluorescence of the vapours of iodine, anthracence, and retene was examined by the same method, but with negative results.

Glass.

Gortner (Amer. Chem. J., 1908, *39*, 157) exposed several specimens of glass from various sources to the direct action of the sun, and made following observations: Glass which is relatively rich in manganese (about 0.2 — 0.3%) becomes colored in less than a month, the degree of coloration being proportional to the manganese present. Most specimens of glass containing only a small proportion of manganese become colored in less than a year and the color becomes deeper if the time of exposure is increased. The production of this violet coloration is a proof of the presence of manganese, but some specimens of glass although containing this element, do not become colored. A violet background is more favorable to the action of ultra violet rays than any other color. White, yellow, red, and blue act alike, and seem to have no effect on the rate of coloration, while brown and black appear to have a retarding action.

Colors of Minerals.

A record of a large number of observations relating to the changes in color of various minerals and colored glasses on exposure to the action of radium rays and ultra violet light is given by *Doelter* (Monatsh., 1909, *30*, 179; J. Chem. Soc., 1909, Abs., *96*, ii, 363). It follows from the results obtained that, generally speaking, the coloring materials of minerals are not of an organic nature, the colors being due principally to the presence of oxides of iron, chromium and manganese. The change in color under the influence of radium rays is in many cases the outcome of a reducing action while the ultra violet rays have an oxidizing action; consequently ultra violet light and radium rays frequently induce opposite changes. The bearing of the results on the origin of the color of many minerals and precious stones is discussed.

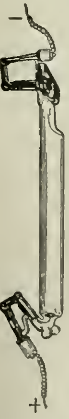


Fig. 3—Special Form of Lamp Designed for Use with Spectro-Polarimeter.

Fluorspars.

Experiments are described by *Meyer* (Ber. deut. physikal. Ges., 1908, *6*, 643; Physikal. Zeitsch., 1908, *9*, 810) the object of which was to determine the nature of the luminescence phenomena exhibited by certain blue fluorspars after exposure to light. During the decay of the thermo-luminescence, and for a considerable time after the disappearance of the visible effect, the emission of ultra violet photochemically active rays can be detected. The intensity of this radiation diminishes gradually, but in the case of fluorspar from Wolsendorf, in Bavaria, the ultra violet radiation could still be detected by the photographic action after the substance had been kept in the dark for one hundred and fifty days. If the fluorspars are heated at 230-260°, the luminescence properties are not developed by exposure to diffused daylight or to an arc lamp; on the other hand, they respond to the light from electric sparks or a mercury lamp even when heated to a bright red heat. The experiments also show that the intensity of the luminescent radiation increases with the length of the period of exposure to the primary radiation when this period is small. Above the certain limit the period of exposure has, however, no influence on the emitted radiation. There appears to be no connection between the effect examined by Meyer and the photo-electric activity.

Carbonyl Chloride.

Cohen and *Becker* (Ber., 1910, *43*, 130) find that when carbonyl chloride is passed through a quartz tube at the ordinary temperature, and at the same time submitted to the action of light from a mercury-quartz lamp, it is partly decomposed into carbon monoxide and chlorine. When 1 c. c. of carbonyl chloride is passed through the quartz tube (20 cm. long and 0.5 cm. in diameter) per minute, the amount of decomposition was 3.3-4%. The effect is chiefly due to the short ultra violet rays, since when tubes of Uviol glass were used, which are only transparent to waves of greater wave-length than 265 $\mu\mu$, the decomposition was only 0.46-0.5%. In ordinary glass tubes there was no decomposition. Coehn and Becker remark that in all the cases hitherto examined, namely, the photochemical equilibria of sulphur trioxide, hydrogen chloride, and carbonyl chloride, the actual equilibrium is affected only by ultra violet rays. Rays of greater wave-length simply act catalytically on the attainment equilibrium.

Iron Compounds.

The action of ultra violet light on ferric sulphate, nitrate and chloride is noted by *Ross* (J. Am. Chem. Soc., 1906, 790) who used an arc between aluminum electrodes as a source of ultra violet rays. The action of light on ferric salts is much increased by the presence of some organic compound as cane sugar which of itself will not reduce these salts but does so under the influence of light. Hence Ross employed a definite amount of sugar in the iron solutions which were exposed to light. The amount of ferric salt reduced is approximately proportional to the time of exposure. A 1/5 normal solution of ferric chloride containing 10 grams of sugar per 50 cc. of solution gave results as follows:

Time of exposure	$FeCl_2$ formed in cc. of 3 N/400 solution.
10 minutes	2.53
20 minutes	4.70
30 minutes	7.15

Varying the temperature of any ferric salt solution was found to have a slight effect on the rate of reduction.

Chloroplatinic Acid.

Boll (Compt. rend. 1913, *156*, 138; J. Chem. Soc., 1913, Abs., *104*, ii, 171) has studied the rate of hydrolysis of tetrachloroplatinic acid when submitted to rays of different energy. The light from a mercury-vapor lamp was dispersed by two quartz prisms, and certain of the resulting rays were used as a source of energy, the amount reaching the acid solution being controlled by a screen, consisting of a cell containing a dilute solution of caffeine, the concentration and thickness of the layer being varied.

Rotary Dispersive Power.

An account is given by *Lowry* (Proc. Roy. Soc., 1908, A, 81, 472; J. Chem. Soc., 1909, Abs., *96*, ii, 200) of improvements which have been made in the method of determining rotary dispersive power. As a result of these, the intense line spectra yielded by metallic arcs can be used for polarimetric measurements. For this purpose a parallel beam from the arc is thrown onto the slit of a constant deviation spectroscope. An achromatic lens, which is substituted for the observing tube, is used to throw a magnified image of the slit onto the polarizing prisms which give a triple field. By suitably adjusting the constant deviation prism, the whole field can be illuminated with monochromatic light of any desired wavelength. For observations with ultra violet light, an arc passed between a carbon and a magnetite electrode is used. A beam from this is thrown by a quartz condenser onto the field of the polarizing Foucault prisms, and by means of a quartz-calcite lens, substituted for the analyser-telescope a diminished image of the field is thrown on the slit of an ultra violet spectroscope. The spectrum is photographed, and the line, for which the intensity in the three parts of the field is the same, is identified on the negative.

Rotation of Plane of Polarization.

The magnetic rotation of the plane of polarization for ultra violet rays of different wave-lengths have been examined by *Sirks* (Physikal. Zeitsch., 1913, *14*, 336; J. Chem. Soc. 1913, Abs. *104*, ii, 458), who conducted experiments with oxygen, hydrogen, and carbon dioxide. In the case of oxygen, measurements of the rotation extend to $\lambda = 265.4$ of hydrogen to $\lambda = 237.8$, and of carbon dioxide to $\lambda = 248.2\ \mu\mu$. The rotation increases rapidly as the wave-length of the ultra violet light diminishes, and the values for the different gases appear to fit as satisfactorily with the data obtained by Siertsema for the rotation of rays in the visible spectrum. By combining the two series of results, and plotting the rotation (relative to the rotation for the yellow mercury line) as ordinate against wave-length as abscissa, it is shown that continuous curves are obtained in the case of each of the three gases. The curve for oxygen is much lower than the curves for the two other gases, and of these the hydrogen curve the higher. The observed magnetic rotation of ultra violet rays in hydrogen is shown to be at variance with the assumption that the action of the molecules on the ultra violet light can be referred to a single type of electron.

Change in Surface Tension.

A number of aqueous solutions of measured surface tension were subjected for either two or three minutes to the action of the light from a high-tension arc between aluminum electrodes by *Marenine* (J. Russ. Phys. Chem. Soc. 1913, 45, Phys. Part, 28-30; J. Chem. Soc. 1913, Abs. *104*, ii, 390), and their surface tensions then re-measured. Water and 3% magenta solution showed no change, 30% resorcinol solution showed a decrease of 9.6%, this being probably due to chemical changes; while 10% solutions of eosin, sodium sulphite and potassium permanganate, and also 1% methyl-violet and 20% potassium nitrate solution, showing increases in surface tension varying from 3.2 to 5.1%. Further measurements demonstrate that the increase in surface tension reaches a maximum approximately 1.5 minutes after the action of the light ceases. The surface tension subsequently falls continuously to the original value, which is sometimes attained only after thirty minutes. A quartz mercury lamp of great actinic power does not cause any such increase in the surface tension, and it seems likely that the phenomenon is due to an action of electrical character.

Ionisation.

In order to ascertain whether certain gases or vapours can be ionised at the ordinary temperature by ultra violet light of moderately long wave length, experiments have been made by *Hughes* (Proc. Camb. Phil. Soc., 1911, *16*, 376; J. Chem. Soc. 1912, Abs. 102, ii, 5) with carbon disulphide, carbon dioxide, stannic chloride, and zinc ethyl. In no case could ionisation be detected, although for the same amount of light energy, the leak from a zinc or carbon surface would have been about 106 times that of the smallest effect which was measurable with the arrangement of apparatus employed. Solid compounds of zinc and tin were found to be photo-electrically active.

Moreau (Compt. rend., 1902, *135*, 898) finds that conductivity of a flame containing salt at a constant temperature depends on the E. M. F., the distance between the electrodes, which consist of small, jat, platinum condensers plunged in the flame, and the concentration of the salt solution, the evaporation of which supplies the salt to the flame. The results show that there is no dissociation in the vapor of the salt before the introduction of the electrodes; the conductivity of the flame before the ionisation ocurring mainly at the negative electrode, and is thus analogous to the conductivity of gases in the neighborhood of a metal illuminated with ultra violet light.

Electrons.

Measurements have been made by *Hughes* (Phil. Trans., 1912, A., 212, 205; J. Chem. Soc., 1912, Abs., 102, ii, 883) of the maximum velocity with which photo-electrons are emitted from the surface of various metals subjected to the action of monochromatic ultra violet light. The surfaces were prepared by distillation of the metals in a liquid-air vacuum. The data obtained for calcium, magnesium, cadmium, zinc, lead, antimony, bismuth, and arsenic show that the energy of the fastest electrons is proportional to the frequency of the incident light.

In an investigation on the spectral extension of ultra violet vibrations and its relation to the different crystal systems, *Eisenmann* (Ber. Deut. physikal. Ges., 1912, *14*, 315; J. Chem. Soc., 1912, Abs., 102, ii, 506) has deduced expressions for the frequencies of vibration of the atom and electron, and these are applied in the calculation of the maximal energies for the atoms of different elements, assuming that the number of the neighboring atoms which exert an influence on the vibrations of a particular atom is dependent on the crystalline system to which the element in question belongs.

Photo-Electric Activity.

According to Hughes, dry zinc chloride shows no photo-electric activity, although photo-electric currents of considerable intensity are obtained with the moist substances. *Willows* (Phil. Mag., 1912 (iv), 24, 891; J. Chem. Soc., 1913; Abs., *104*, ii, 4), states that this observation is probably connected with the fact that the moist halogen salts of zinc emit large quantities of positive and negative ions when heated to 300°, whereas the dried salts are inactive. The halogen salts are evidently unstable, and ultra violet radiation in presence of moisture represents one of several agents, the action of which suffices to bring about decomposition.

The disintegrating effect which ultra violet light has been found to exert on gold leaf exposed to its action is shown by *Stark* (Physikal Zeitsch, 1908, 9, 894) to be in accordance with theoretical requirements. An experiment is described which appears to show that positively charged atoms are emitted in consequence of the absorption of ultra violet light.

Photo-Electric Effect of Various Compounds.

The emission of electrons by various solid compounds subjected to the action of ultra violet light has been investigated by *Hughes* (Phil. Mag., 1912 (vi), 24, 380). Mercurous and mercuric iodide, mercurous and mercuric chloride, antimony tri-iodide, and bismuth trichloride show well-marked effects after exposure for some time to the ultra violet rays, but dry zinc chloride and phosphoric oxide appear to be inactive. The action is very small in the case of lead iodide and almost negligible for ferric chloride. Although large and gradually increasing effects are obtained with the above-mentioned halogen salts, the initial photo-electric activity of these substances is either zero or very small, except in the case of antimony tri-iodide. From the observed behavior, it appears that the salts themselves are not photo-electric for light of the wave-length employed, and that the emission of electrons is due to the primary decomposition of the halogen salt by the light and the subsequent action of the rays on the separated metal. The more stable the salt, the less is the effect produced. Although zinc chloride and phosphoric oxide are inactive when dry, they show a distinct effect in contact with moist air. This cannot be accounted for by the photo-electric activity of water.

Experiments with anthracene show that the photo-electric activity of this substance is produced entirely by light of wave-length shorter than $\lambda = 2002$. The maximum emission velocity for $\lambda = 1849$ is 0.87 volt.

Experiments by *Pohl* (Ber. Deut. physikal Ges., 1909, 715) with an alloy of potassium and sodium and ultra violet radiation of short wave-length show that the photo-electric behavior of the alkali metals in polarized light is the same as that observed in the case of other metals.

Variations of the Temperature-coefficients of Photochemical Reactions

Padoa and *Minganti* (Atti. R. Accad. Lincei, 1915 (v), 24, ii, 97; J. Chem. Soc., 1915, Abs. *108*, ii, 719) have measured the temperature-coefficients of Eder's reaction,

$2HgCl_2 + (NH_4)_2C_2O_4 = 2HgCl + 2NH_4Cl + 2CO_2$, proceeding under the influence of lights of various wave-lengths. Besides white light, ultra violet light, with the luminous zone $\lambda = 400$ 280, and maximum, intensity at 366, dark blue with the zone $\lambda = 478$ — 410 and the maximum at 366, and the green with the zone $\lambda = 540$—505 and the maximum at $\lambda = 533$, were used. In the case of the green light, the reaction proceeds so slowly that a little dilute aqueous tetrachromofluorescin was added as a sensitizer; the latter was also employed in some of the experiments with white light.

For the temperature interval 20-40°, the temperature coefficients are as follows: white light, 1.29; ultra violet 1.05, dark blue, 1.21; green, with sensitizer, 1.75; white with sensitizer, 1.50. In accordance with the results previously obtained with phototropic substances, the temperature-coefficients increase with the wave-length of the activating light. With white light, the sensitizer used raises the temperature-coefficient considerably, since it gives preponderance to the action of the yellow and green rays, which without it are of slight activity. Red light has no action even in presence of a sensitizer.

Certain evidence indicates that, in the assimilatory process of plants under the influence of chlorophyll, the temperature-coefficient is considerably greater than 1.

Chemical Action of Light Contrasted with that of the Silent Electric Discharge

Berthelot (Ann. Chim. Phys., 1900 (vii), 19, 150) found benzene to remain unaltered when exposed to bright sunlight for several months in sealed tubes containing hydrogen or argon, although it combined with oxygen, yielding resinous products; if placed over mercury, a brown sediment, which is derived from the thiophene present in the hydrocarbon, forms at the junction of the liquids. Carbon disulphide, under these conditions, undergoes a partial decomposition, and the sides of the containing vessel become coated with a brown deposit; when exposed to diffused light, it remains unaltered, and does not react with hydrogen or argon. When a mixture of argon and gaseous carbon disulphide is submitted to the action of the silent discharge for three months in diffused light, the electrodes being maintained at a difference of potential of 200 volts, the former gas remains unaltered, while 60 per cent. of the latter is converted into yellow, resinous products.

Reaction Nuclei as Catalyzers

Weigert (Ann. Physik., 1907 (iv), *24*, 243) observes that when gaseous systems containing chlorine are exposed to light, molecular complexes are probably produced, which act catalytically as reaction nuclei. At these nuclei, it may be supposed, equilibrium between the reacting gases is established with such rapidity that the further progress of the reaction is conditioned by the rate of diffusion to these nuclei of the remaining portions of the gases. According to this theory, therefore, photochemical reactions may be brought under the category of heterogeneous reactions. Experimental evidence is brought forward showing that when chlorine is exposed to ultra violet, violet, or blue light, the production of fog may be actually observed. If Weigert's view is correct, then reactions which are not themselves affected by light should be catalytically affected by the presence of the reaction nuclei already mentioned. In this connection, it is shown that the formation of water, the formation of sulphur trioxide, the dissociation of carbonyl chloride, the decomposition of ozone, the Deacon chlorine process, and the formation of ammonia from its elements are reactions which, although not themselves sensitive to light, may be sensitised by adding chlorine and exposing to light. The fact that all photochemical reactions known to Weigert were unimolecular, and that the temperature-coefficient of these reactions was of the same order as the temperature-coefficient of a diffusion process is regarded as lending support to the conception of photochemical reactions as heterogeneous catalytic reactions. That the activity of chlorine and other substances sensitive to light does not cease immediately when exposure is stopped is also in favor of the foregoing view that definite nuclei are produced.

Law of Mass Action

Hanssen (Compt. rend. 1907, 145, 564) asserts that many photochemical actions such as the decomposition of oxalic acid and hydrochloric acid and the union of carbon monoxide and chlorine, are subjected to the ordinary law of mass action. The action of a strong light on glucosides, like saponin and cyclamin; enzymes, like rennet and trypsin and on toxins and immune-serum impairs all of them, the action being largely due to the ultra violet rays. The weakening action proceeds regularly, and may be expressed by means of the ordinary equation for a uni-molecular reaction.

Luminescence

The luminescence produced by a number of substances under a series of conditions have been determined by *Farnau* (J. Physikal. Chem., 1913, *17*, 637; J. Chem. Soc., 1913, Abs. *104*, ii., 1001). The experiments include observations on the cathode-luminescence, canal ray luminescence, ultra violet luminescence, luminescence by heating, luminescence by trituration, chemiluminescence, and crystal-luminescence of a series of the haloids of sodium, potassium, cadmium, zinc, mercury, lithium, rubidium and caesium, together with, in a few cases, the carbonates and sulphates. Farnau draws the conclusion that luminescence of all kinds is due to a chemical reaction. Increase in the rate of the reaction, brought about either by a catalytic agent or by increase in the temperature, increases the luminescence. The nature of the luminescence is but slightly altered by the nature of the catalyst or the temperature change. The nature of the luminescence in most cases depends upon the metal of the salts, but in a few cases the acid radicle has an influence. The nature of the luminescence is the same no matter how it is produced.

Different Effects of Ultra Violet Light

From a summary of results obtained in the investigation of the action of ultra violet light on gases *Ransauer* (Ber. Deut. Physikal. Ges., 1911, *13*, 899; J. Chem. Soc. 1912, Abs. 102, ii, 5) concludes it is necessary to differentiate between (1) purely chemical action, (2) formation of fog nuclei, and (3) formation of carriers of electricity. Pure chemical changes, such as the transformation of oxygen into ozone, are brought about by light which is not at all readily absorbed. Such changes are quite independent of the formation of fog nuclei or ions. The formation of fog nuclei is also due to chemical action in the first instance, and only differs from changes of the first type in that the end-products are solid or liquid particles. These changes are also independent of the liberation of electrons. The third kind of action differs from the other two in that it is determined by ultra violet rays which are selectively absorbed. The rays which are mainly responsible for this type of change correspond with wave lengths in the extreme ultra violet region.

Variation in Wave-Lengths

Berthelot and *Gaudechon* (Compt. rend., 1912, *155*, 207) compare the effectiveness of different ultra violet rays in the photochemical synthesis of quaternary compounds in the polymerisation of different gases and in the photolysis of acetone. Equal volumes of carbon monoxide and ammonia combine in a few hours to give formamide under the influence of the ultra violet rays $\lambda < 0.2\ \mu$) from a mercury-quartz lamp. Combination also takes place slowly with medium ultra violet rays ($\lambda=0.2$ to $0.3\ \mu$), but there is no combination under the influence of initial ultra violet or solar rays ($\lambda < 0.3\ \mu$). On the other hand, formamide slowly decomposes when submitted to ultra violet rays, the reaction being complicated by dehydration and formation of hydrogen cyanide. Light, less markedly than heat, produces polymerisation (compare Compt. rend. 1910, *150*, 1164). Cyanogen exposed to sunlight slowly polymerises. Acetylene, under the same conditions, is not changed, but it too polymerises under the influence of the ultra violet rays from a mercury-quartz lamp. Acetone is rapidly decomposed into carbon monoxide and ethane by the rays from the lamp, but is not acted on by sunlight. A 10% aqueous solution of acetone behaves similarly, except that with sunlight the acetone is hydrated and decomposed, giving methane and acetic acid.

Berthelot and *Gaudechon* (Compt. rend. 1913, 156, 889) have studied the stability of the hydrogen compounds with the members of the chlorine and oxygen groups of elements towards light of different wavelength. As in the case of decomposition by heat, it holds good that, in the same family of elements, the stability of the hydrogen compounds with respect to light decreases as the atomic weight increases. Substances which are only dissociated at high temperatures are similarly only affected by the very rapid vibration of the extreme ultra violet light. Hydrogen chloride requires ultra violet light ($x < 0.2\ \mu$) for decomposition which even then is slow, while under similar conditions hydrogen bromide is rapidly and completely decomposed. Hydrogen iodide is decomposed by blue and violet light. A similar relationship is found in the case of water-vapor, hydrogen sulphide, selenide and telluride.

This rule holds good in the case of the nitrogen and carbon groups (Compt. rend., 1913, *156*, 1243; J. Chem. Soc. 1913, Abs. 104, ii., 458). Zinc ethyl is rapidly decomposed by the light from a quartz mercury lamp; carbonyl chloride is slowly decomposed by the extreme ultra violet rays, while sulphur hexafluoride is unaffected by the light from a mercury lamp.

Fluorescence as an Aid in Sterilizing Water

The use of fluorescent bodies to assist in the sterilization of water, particularly water rendered dull by humic substances, has been suggested. The Quartzlampen Ges. (British Patent 112,149, Dec. 6, 1916) recommend the addition to water which is to be exposed to the rays from a quartz burner, of a dye, color or fluorescent body. Suitable substances are eosin, rhodamines, fuchsin, methylene blue, Nile blue, phenazine, toluylene red, phenosafranine, fluoresceine, etrachloro-, tetrabromo-, tetraiodo-, tetrachlorotetrabromo-, tetrachloro-tetraiodofluoresceine, chloride of acridine, chrysophanic acid, phenylquinaldine, quinine, hydrastinine, chlorophyll, alcoholic extracts of green vegetables, and uranium or iron salts.

The flame of carbon disulphide burning in nitric oxide is shown by *Tassilly* and *Gambier* (Compt. rend. 1910, *151*, 342) to have a feeble sterilising action on water containing bacteria exposed to its light.

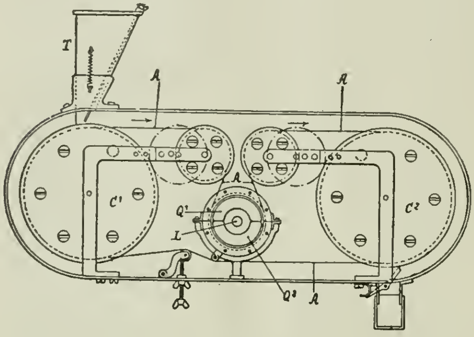


Fig. 4—Olivier's Apparatus for the Vulcanization of Rubber.

Tables of data on the chemical action of tropical sunlight obtained by *Fowler* (Mem. Manchester Phil. Soc., 1908, 52, xiv, 1; J. Chem. Soc. 1908, Abs. ii, *94*, 914) from measurements made in Calcutta and on the Mediterranean and Arabian Seas are recorded. The highest record corresponds with an actinic effect which is forty-two times as great as the lowest record obtained on a bright December day in Manchester. No relationship appears to exist between the photochemical and sun-stroke effect of sunlight. Solutions of bleaching powder lose their available chlorine with great rapidity on exposure to tropical sunlight. The effect is much more marked in the case of dilute solutions than it is in strong solutions.

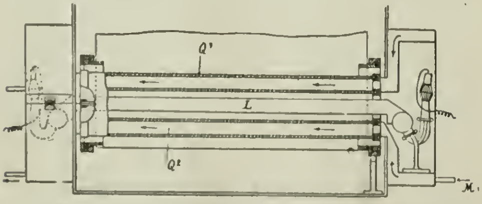


Fig. 5—Quartz Jacketed Lamp Used in Olivier's Apparatus Above.

Vulcanization of Rubber

The practical vulcanization of rubber by the ultra violet ray may be carried out with *Olivier's* apparatus (U. S. Patent 1,256,496, Feb. 12, 1918). Olivier notes that rubber vulcanized by means of ultra violet light is particularly useful for cementing purposes, since the treatment produces thick elastic liquids which are real liquid rubbers. With former cementing processes, the surfaces of rubber to be cemented were coated with a solution containing 6 to 12 per cent. of rubber and usually several layers of such cement were necessary to effect the cementing. With this method of producing the solution a much more dilute solution can be obtained than heretofore. In fact, the dilution may be 0.5 to 0.6 per cent. When this latter solution is used for cementing, the two rubber surfaces absorb the solution and, upon placing the surfaces in contact it is claimed that a real autogenous union of the two rubber surfaces can be obtained. When surfaces of rubber are so united, they are not separated by a comparatively thick layer of cement, as with former cements, but they are in immediate contact on account of the penetration due to the dilution of the solution.

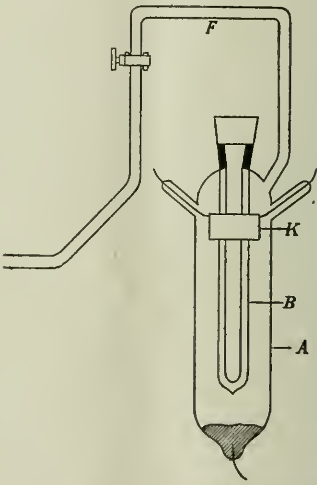


Fig. 6—Fischer's Mercury Arc Lamp for Formation of Ozone.

In carrying out the process, the first factor to be fixed is the duration of exposure to the ultra violet rays. Experience has shown that after a certain time of exposure, the decomposition of the rubber increases rapidly, whereas the vulcanization effect only increases to a small extent. The duration of exposure of course changes according to conditions, depending on the size lamp used, the thickness of the solution, and the distance of the solution from the lamp. When using a 220 volt, 3 ampere, quartz lamp and with a solution a fraction of a millimeter in thickness placed at a distance of 5 centimeters from the lamp, the duration limit would be forty seconds. When solutions of rubber are being vulcanized with ultra violet rays, the sulphur usually used can be replaced by sulphides and in a general way, by any sulphides which can be decomposed by ultra violet rays, such as carbon disulphide, allyl sulphide or antimony sulphide. After vulcanization, when these sulphides are used, there is no uncombined sulphur left in the solution as, according to Olivier, it is precisely the sulphur which is decomposed out of the sulphides which allies itself with the rubber. Vulcanization can also by effected by adding at the same time to the solution, ordinary free sulphur and carbon disulphide. Under these conditions, vulcanization occurs concurrently between the rubber and the sulphur decomposed out of the sulphide.

The apparatus is shown in *Fig. 4*, in which C^1 and C^2 are two cylinders, supported in a housing having a hopper T for the introduction of the rubber solution. L is an ultra violet lamp and A is an endless belt which passes about the lower part of the lamp, around the cylinders C^1 and C^2 and over two rollers placed above the lamp. The rubber solution is carried by the belt from the supply hopper T around the lamp, where vulcanization takes place and the vulcanized product is removed by the scraper N. The burner is kept cool by water jackets Q^1 and Q^2, which are made of quartz.

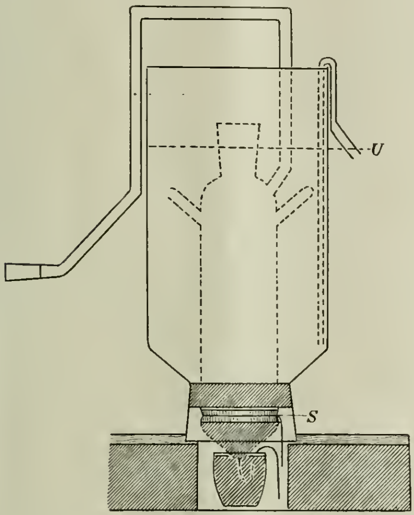


Fig. 7—Detail of Fischer's Lamp, Showing Tin Foil Ring.

The lamp L with quartz jackets Q^1 and Q^2 is shown in *Fig. 5*. The housing of the lamp is mounted on brackets so the lamp may be rocked in starting. Water is admitted to the jackets by the pipe M.

The Fluorometer

An instrument is described by *Winther*, (Zeitsch. Elektrochem., 1913, *19*, 389; J. Chem. Soc. 1913, Abs. *104*, ii, 458) termed a fluorometer, by means of which the energy of a ray of given wave-length can be measured irrespective of the presence of ultra red rays The principle involved consists in allowing a beam of light from a normal lamp, after passing through light filters, to enter a rectangular quartz vessel, which is filled with a fluorescent material. In this way a narrow, fluorescent beam is produced in the vessel. A second beam is produced parallel with and a few millimeters removed from the first beam, by the light under investigation. This second beam enters at the opposite side of the vessel. By means of a lens and cross wire moving over a graduated scale, the position of equal brightness is measured. The fluorescent solutions employed by Winther are: (1) Rhodamine-B, made up of 0.004 gram per litre, useful for wavelengths 600 to 460 $\mu\mu$, and can be used for the ultra violet from 340 $\mu\mu$ and downwards. (2) Sodium flourescein, made up of 0.01 gram per litre + 2.50 cc. of N-sodium hydroxide, useful for wave lengths from 520 $\mu\mu$ down to 254 $\mu\mu$. (3) Quinine sulphate, made up of 0.1 gram per litre + 4 cc. N-sulphuric acid, useful down to 260 $\mu\mu$. In addition to its uses for the measurement of energy values, the fluorometer is serviceable in measuring absorption curves, and also the reaction velocities of light-sensitive and non-sensitive systems. A number of light filters for various regions are described by Winther, and a criticism of many of the older light filters is given.

Fischer Ultra Violet Lamp

Fischer (Ber., 1905, 2630) constructed a mercury arc lamp with quartz jacket suitable for chemical purposes which he used in experiments on the formation of ozone. This consists of an exhausted double-walled

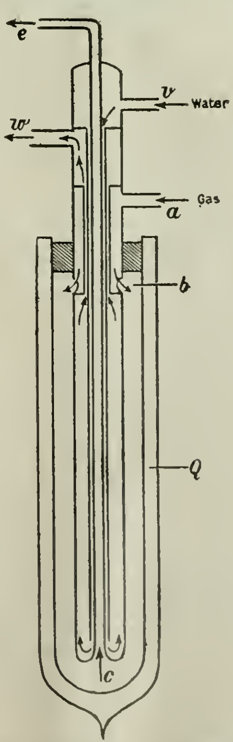


Fig. 8—Method Employed for Internal Cooling of Fischer Lamp.

quartz cylinder B (*Fig. 6*) fixed with sealing-wax into the neck of a surrounding cylindrical glass vessel A, connected with an air pump by the tube F. The anode consists of an iron ring K, which surrounds the quartz cylinder and is suspended by means of two platinum wires fused into the walls of the glass vessel. Mercury is placed in the bottom of the latter to serve as cathode. Near the bottom of the glass vessel is an outer ring, S, of tin foil (*Fig. 7*), connected with a copper wire so that an induction coil may be used for lighting. The glass vessel dips into a small mercury trough into which the current is led. The lamp is operated at 20 volts and 5 amperes. Arrangements are made to cool the lamp both internally and externally, so that the temperature in the interior of the lamp is kept down, thus maintaining a low density of the mercury vapor, and favoring the formation of ultra violet light. External cooling is accomplished by a water jacket shown in *Fig. 7* having the water level at U, while the internal cooling device is shown in *Fig. 8*. The latter is placed in the double-walled quartz vessel Q. Water enters v and leaves by w. When exposing gases to the light, these may be admitted at a, pass into the quartz vessel at b, flowing downwardly to c, where they move upwardly to the exit e.

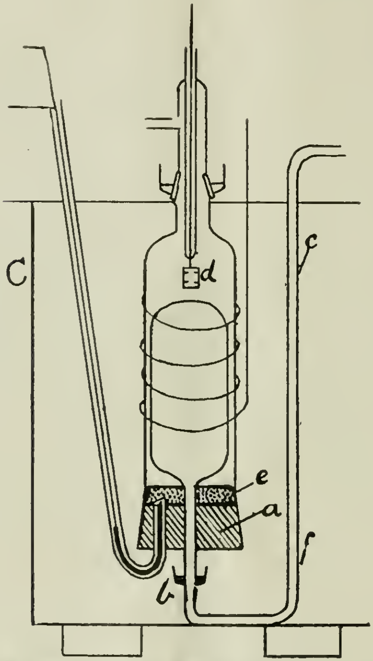
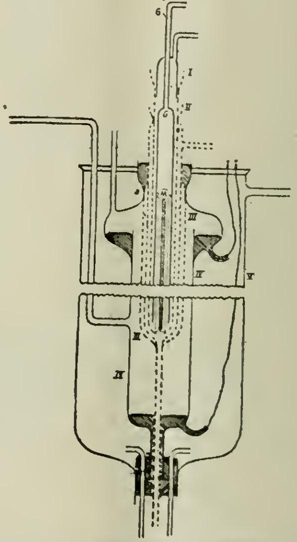


Fig. 9—Chapman, Chadwick and Ramsbottom's Lamp for Treating Gases.

Lamps for Treating Gases

The exposure of gases to ultra violet light was carried out by *Chapman, Chadwick* and *Ramsbottom* (J. Chem. Soc. Trans. 1907, *91*, 945) in apparatus of the form shown in *Fig. 9*. A bulb of quartz, in which the gases are placed that are to be exposed to the light, is enclosed in a glass mercury lamp of which the cathode is a pool of mercury and the anode a short cylinder of iron suspended in the upper part of the glass container. The latter is exhausted by means of a Sprengel pump. The quartz bulb has an outlet tube passing through the bottom of the lamp and communicating with a pump. The lamp is operated on a current of 6 amperes.



(Courtesy, Library of the Chemists' Club, New York.)

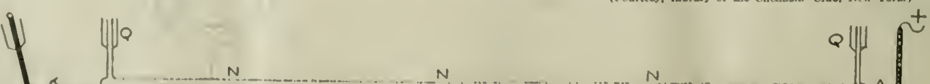
Fig. 10—Coehn and Becker's Lamp for the Oxidation of SO_2.

An apparatus recommended by *Coehn* and *Becker* (Zeitsch. f. physik. Chem., 1910, *70*, 90; Zeitsch. f. Elektrochem. 1907, *13*, 545) for photochemical work and used by them in the oxidation of sulphur dioxide is shown in *Fig. 10*.

The lamp consists of a glass vessel IV in which the double-walled quartz vessel II and III is placed. A mercury seal is used at the top of the vessel IV. The lamp is placed in a water-jacket or cooling vessel V. In order to make the burning uniform a magnet M is placed in a glass tube in the lamp as shown. A

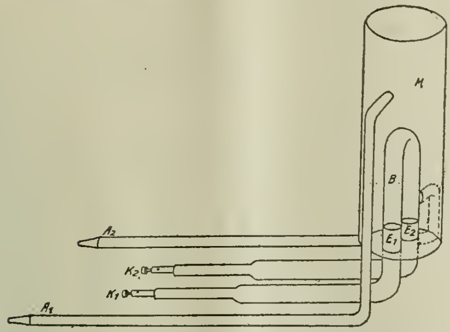
Fig. 11—Burner for Technical Applications of Photochemistry.

(Courtesy, Library of the Chemists' Club, New York.)



quartz tube I is inserted in the vessel II through which gases may be passed by means of the inlet and outlet tubes G.

A burner for technical applications of photochemistry is shown in *Fig. 11.*



(Courtesy, Library of the Chemists' Club, New York.)

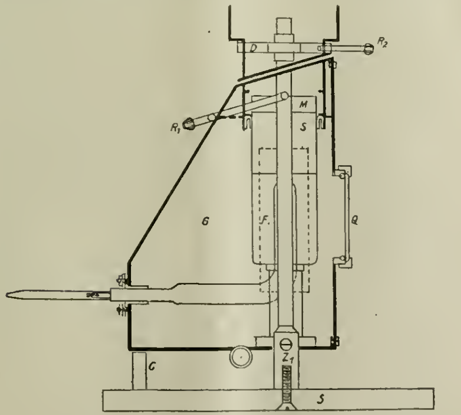
Fig. 12—Weigert's Burner for Treatment of Gases.

A quartz lamp K L A has a length of 115 cm. The light zone is maintained in the tube L, 1.8 cm. in diameter. A tube R, 5 cm. in diameter and 100 cm. in length, is fused on the tube L.

Reaction mixtures are passed in and out by the openings Q, Q. The tube R is wound with nickel wire and jacketed with asbestos. The temperature is determined by thermo elements at N.

A quartz-jacketed burner used by *Weigert* (Zeitsch. f. physik. Chem. 1912, *80,* 69) especially for exposure of gases to ultra violet rays has the form shown in *Fig. 12.*

A mercury arc is formed in the inverted U tube B, between the surfaces of mercury E$_1$, and E$_2$, electrical connection being made at K$_1$ and K$_2$. M is a mantle of thin quartz enclosing the burner. Capillary tubes of Quartz, A$_1$ and A$_2$, are used for changing the gaseous atmosphere in the space about the burner. The apparatus is mounted in a watertight casing G shown in *Fig. 13.* Q is a quartz plate serving as a window for external exposures. V is an arrangement which enables the apparatus to be made gas tight.



(Courtesy, Library of the Chemists' Club, New York.)

Fig. 13—Watertight Casing for Above.

A "Home-Made" Ultra Violet Lamp

At the time when there were no quartz mercury-vapor lamps on the market in this country *Bovie* (J. Biol. Chem. 1915, 315) (Laboratory of Plant Physiology, Harvard University) required a source of ultra violet light for certain biological and photochemical investigations. He constructed quartz lamps which he states are less expensive than any of the commercial lamps known to him and which after 4 years of use still give excellent results. The lamps are not difficult to make and the design of this "home-made" apparatus can be altered to suit particular requirements. The quartz must be worked in an oxyhydrogen flame, and the burner must be adjusted so as to give the highest temperature possible; but the technique required for shaping the lamps is simpler than that required to make an ordinary T-joint in glass tubing, since the quartz joints do not have to be annealed. A good vacuum pump is required for exhausting the lamp. The greatest difficulty is found in making the seals at the points where the electrodes enter. The literature contains a number of more or less complicated and impractical methods, but the seals described below are easily made and are efficient.

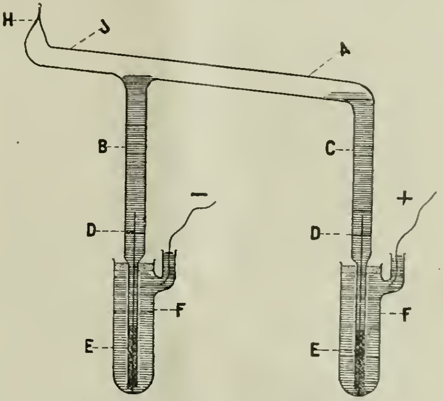


Fig. 14—Bovie's "Home-Made" Quartz Lamp.

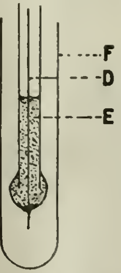


Fig. 15—Bovie's Apparatus, Detail of Seal.

Fig. 14 shows a simple form which the lamp may take.[1] A is a quartz tube 1 cm. in diameter. One end is bent downward to form the positive electrode C. A quartz tube of the same diameter is sealed in, near the other end, to form the negative electrode B. The distance between B and C is about 10 cm. The end of the tube A forms a condenser. The lamp is sealed, after exhausting at H. The tube A should be inclined to the horizontal position at an angle of 6° to 7°, the end J being higher, so that the condensed mercury will flow back into C. Pieces of 5 mm. quartz tubing are sealed to the lower ends of B and C. These in turn are set in mercury cisterns F, F (made of glass); test-tubes may be used. The small tubes are sealed at E with De Khotinsky cement.[2] The detail of the seal is shown in *Fig. 15*. The bulb of wax on the outside is necessary in order to make the seal air-tight. The iron wire D conducts the electric current through the wax seal. The mercury cisterns F, F radiate heat and also make the seal at E more secure by furnishing an additional mercury seal.

During the process of pumping the lamp should be turned, to allow the mercury to flow out of B and C, so as to free any imprisoned air bubbles. The lamp should then be placed in an upright position and the mercury in the upper parts of B and C boiled vigorously, keeping the wax at E cool by having the lamp stand in a dish of water. Lastly, the lamp should be connected with a 110 volt direct current (with suitable resistance in series with it), and run for one or two hours. When it appears to run evenly the vacuum pump should be stopped, and the lamp sealed off at H. The tube A should be drawn down to a small diameter at this point before the pumping begins.

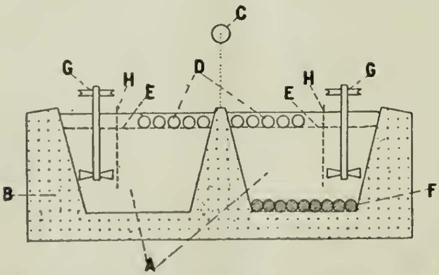


Fig. 16—Bovie; Arrangement of Apparatus for Experiment in Photochemistry.

The lamp should be used on a 110 volt direct current with 5 or 6 sixteen candle power bulbs in multiple as resistance. The lamp will carry from 1.25 to 1.5 amperes, depending upon the amount of cooling at the electrodes B and C. When convenient it is desirable to arrange the experiments so that the lamp can stand in a dish of water, with the water surface well up on B and C. The lamp is started by tipping, or a Bunsen flame may be directed upon the surface of the electrode C. When the mercury boils the arc will start. As the lamp is made of quartz there need be no fear of breaking by sudden heating or cooling.

The tube A between B and C should be made of transparent quartz, but all other parts can be made of the cheaper translucent, fused silica. A lamp made for physical experiments, where only a small beam of ultra violet light was needed, was made entirely of fused silica, save for a small space between B and C, about 1 cm. long, where a small piece of transparent quartz was inserted.

Fig. 16 shows a convenient arrangement for an experiment in photochemistry. The drawing shows a cross-section of the lamp, baths, tubes, etc., as used by Bovie in studying the temperature-coefficient of the coagulation of egg-albumin by ultra violet light. A, A are copper trays set in the insulating case B. C is the lamp. The quartz test-tubes which hold the albumin are supported at D by the shelves of E, E. The water in one of the trays is heated by the electric heating coil F, while the water in the other tray is kept at 0°, by placing chopped ice below the shelf E. The electric current in the heating coil is controlled by a thermoregulator. G, G are stirrers. The partitions H, H serve to prevent the stirrers from disturbing the surface of the water, and thus causing irregular variations in the reflection of light at the surface of the water. In this experiment the mercury cisterns (shown at F, F in Figure 1) stood in the ice water bath.

Fig. 17 shows another of the possible forms of the lamp. It will be seen that the tube A is vertical. The electrode C, which is left open at the bottom, dips into a cistern of mercury M. This lamp was designed to run on a 220 volt circuit, and the distance between B and C is 30 cm. The lamp, however, will work as well on a 110 volt circuit; for, as will be seen presently, the distance between C and B is easily adjusted. The arc is started in this lamp by elevating the mercury cistern M until the mercury in C comes in contact with that in B. The distance between the surface of the mercury in M and the surface in C is equal to the height of the barometric column, since the surface at M is exposed to the air. When the lamp is running on a 110 volt circuit the arc is not stretched down as far as when running on 220 volts. In place of the mercury cistern M, one can use a smaller chamber closed at the top, with the air space above the mercury connected with a water aspirator. The height of the mercury in C can then be controlled by varying the air pressure above the mercury in the cistern. With this arrangement the distance between M and C may be shorter. An air trap L is inserted between M and C to prevent the accidental entrance of air bubbles into A.

It will be noticed that the condenser J is not in a line with A, but is a little to one side. This is important, for a certain amount (about half) of the condensed mercury must be returned to the electrode

---

[1] The form of this lamp is copied from a lamp made by Dr. C. A. Kraus.

[2] This cement may be obtained from A. De Khotinsky, [illegible] Drexel Avenue, Chicago, Ill.

B, else it will boil dry. The condenser J and the electrode B are provided with copper radiators, K. (The radiators were taken from discarded Nernst lamps.) By using these radiators the lamp could be made to carry a current of four amperes. With this current density and with an arc 30 cm. long the lamp emits such an abundance of ultra violet light that the air in the room is quickly filled with ozone. The photochemical power of the lamp may perhaps best be judged from the fact that an exposure of one or two minutes at a distance of one meter will produce such a "sunburn" as to cause the skin to peel.

A More Powerful Burner

A more powerful lamp is described by *Bovie* (J. Am. Chem. Soc. 1915, 1721) who states that the improved lamp is so simple, efficient and durable that the employment of ultra violet light in biological and chemical investigations should be decidedly facilitated by its use.

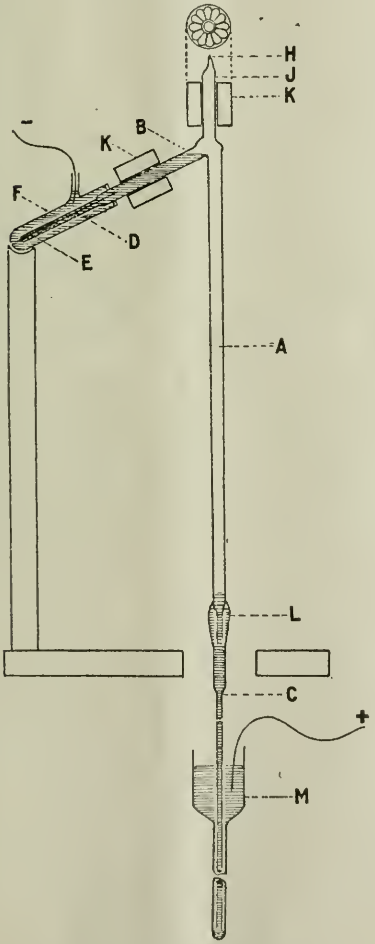


Fig. 17—Bovie; Another Form of "Home-Made" Apparatus.

The principles of the mercury air-pump have been incorporated into the design so that no pump, other than an ordinary water aspirator, is required to exhaust the lamp to a very high vacuum. This feature not only does away with all troubles connected with the original exhaustion of the lamp, but makes it possible to re-exhaust the lamp quickly and easily at any time. The lamp can be re-exhausted without in any way disturbing the chemical substances under investigation and without interrupting the exposure for more than a fraction of a minute. The length of life of the lamp is, therefore, limited only by the durability of the quartz. A maximum of efficiency is obtained by constructing the apparatus so that the exposed substance receives practically all of the light given out. The temperature of the substance which is being investigated is at all times under the control of the operator.

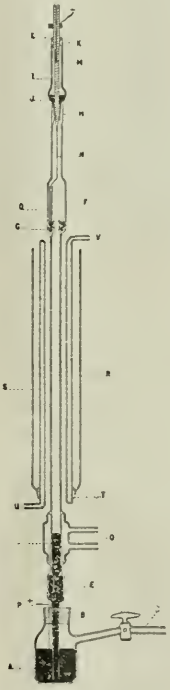


Fig. 18—Details of a More Powerful Form of Lamp Constructed by Bovie.

The lamp consists of a transparent quartz tube, 70 cm. in length, closed at one end with a stopper of invar and inverted in a cistern containing pure mercury. The mercury cistern (A), *Fig. 18*, is closed at the top by a rubber stopper B through which the quartz tube passes. The air pressure in the cistern A may be varied by admitting or removing air through the side tube C. The height of the mercury column D varies with the air pressure in A. The quartz tube is of 7 mm. internal diameter, for the greater part of its length. It is enlarged at E to form an air-trap, also at F to form a condensation chamber, and again at J to form a reservoir for a mercury seal. The construction of the air-trap E will be understood from the drawing. Immediately above the air trap is a water-jacket, O. Water circulating through this jacket serves to keep the positive electrode cool. This makes it possible to greatly increase the current density of the arc. The condensation-chamber F has at its lower end an internal flange which, together with the wall of the chamber, forms a pocket to hold a ring of mercury G which forms the negative electrode of the lamp. The wall of the tube is thickened at H and is ground to receive the conical end of the invar stopper I. This ground joint is sealed with mercury at J. The top of the quartz tube at K is constructed so as to fit closely about the upper part of the invar stopper. The joint here is made practically air-tight by a ring of soft, rubber gum, L. This construction of the joint at K makes it possible to slightly raise or lower the invar stopper without destroying the seal at J. A small hole extends along the axis of the upper part of the invar stopper and opens at M into the space between the joint K and the mercury seal J.

The invar stopper has electrical connections with the mercury ring G by the soft iron wire N. It is essential that the lower end of the iron wire N terminate in a ring which dips well beneath the surface of the mercury. Otherwise when heavy currents are passed through the lamp and the mercury ring G contracts, due to the so-called "pinch-phenomenon," the end of the iron wire will be exposed and will be melted off because of the intense heat of the arc which will thus be formed between it and the mercury ring G. The lower part of the wire is further protected by a small quartz tube Q, the lower end of which dips beneath the surface of the mercury. Without the protection of the quartz tube Q the wire itself, instead of the mercury ring G, will become the negative electrode and the heat thus developed will cause the wire to melt.

The condensation chamber F is cooled by a copper radiator, or better by an air-blast.

The upper surface of the mercury column D serves as the positive electrode of the lamp. The current is conducted to it through the iron wire P which passes out through the rubber stopper B.

The lamp is evacuated as follows: The top of the invar stopper is connected by means of a rubber tube to the water aspirator. The stopper is lifted slightly so as to leave an opening at the ground joint H and the aspirator is started. The air is thus drawn out from the body of the tube. The stopcock C is opened and as the quartz tube is evacuated, the mercury column D rises. The pumping is continued until the mercury column reaches and passes the ground joint at H. The stopper is then pressed down so that the joint is closed. The mercury which has passed above the joint serves as an air-tight seal.

The tube C is now connected with an aspirator and the air pressure in the cistern is reduced. The mercury column falls, leaving a Torricellian vacuum in the space below the invar stopper. In order to remove the last traces of air from the lamp it is necessary to boil the mercury column D during the first pumping, and in order to insure an air-tight seal at H the mercury in J must be boiled each time the seal is made. The occluded gases which are usually contained in the iron wire N and which are driven out during the first few "burning hours" of a new lamp, are removed from time to time by allowing the mercury column D to rise past the joint H. After these gases have been removed, the lamp seldom needs to be repumped. After pumping, the aspirator is disconnected from the invar stopper I, leaving the space above the mercury at J open to the outside air.

The invar stopper should not be heated while it is seated in the grinding at H. There is sufficient expansion of the invar at high temperatures to break the quartz. As long as the partial vacuum is maintained in the space above J, the stopper may be held up out of its seat wtihout losing the mercury seal. The stopper is seated only when the lamp has cooled. It will be understood that the Bunsen flame may be turned directly on the quartz without fear of breaking. After heating the lamp is cooled immediately by a dash of cold water.

The lamp is operated on a direct current in series with a resistance, which, for voltages above 110, should be variable. It carries a current of from 12 to 15 amperes. The maximum length of arc obtainable is dependent upon the voltage of the line upon which the lamp is operated. With 110 volts on the line, an arc of about 9 inches can be maintained. With 220 volts, the lamp burns with an arc over 2 feet long. It is essential that the mercury column D be made the positive electrode; the lamp will not burn if the poles are reversed.

The solutions to be exposed to the light are contained in the triple walled beaker R. The outside wall of the beaker is made of glass. The inside S is a screen for absorbing the heat rays. It is a double-walled quartz tube with the space between the walls open to the outside through the small tubes U and V. The heat rays are absorbed by a stream of water which passes between the walls of the tube. By adding various substances to the water, the double-walled quartz tube may be used as a selective light filter, or if desired, it may be used as a chamber in which to expose gases. The outside wall of the beaker is joined at T to the inner part by a rubber ring which forms the bottom of the beaker. Rubber is very unstable under the action of ultra violet light, and it would be better to have a ground joint at T, but the quartz tube used by Bovie was too thin to stand grinding. The beaker has a capacity of 100 cc.

For measuring the temperature and stirring the solution during the exposure, a device is employed which is not shown in the drawing. It consists of a hollow gold wire (size No. 14 Brown and Sharp gage), bearing two rings of gold which encircle the inside wall of the beaker. The device is given a slow up-and-down motion by a crank on a driving motor. The upright hollow gold wire extends above the beaker and is open at the top, so as to receive one of a pair of thermal junctions made up of No. 32 "Ideal" and copper wires. The other (constant) junction is placed in water in a Dewar flask which is provided with a thermometer. The variable junction is pushed well down inside the hollow gold wire. The free ends of the copper wires are connected with a galvanometer which is sufficiently sensitive so that differences in the temperatures of the two junctions can be read to 0.1°.

The lamp is operated as follows: The line wire is disconnected from the invar stopper I. The beaker R is slipped off over the top of the lamp, and, if necessary, its outer and inner parts are separated at the joint T, so that the surface of the inner part S can be cleaned. The beaker and line wire are now replaced. The variable resistance is set so that when the lamp is short-circuited it will carry between one and two amperes. The stream of water is now started through the water-jacket O. Air is admitted into the cistern A, causing the mercury column D to rise until electrical contact is made with the electrode G. The air pressure in the cistern A is now reduced, and the mercury column falls, stretching out the arc between D and G. The variable resistance is now adjusted so that the lamp carries the desired number of amperes. The current may be varied from less than one ampere to the full carrying capacity of the lamp.

Connections are now made at U and V, water is allowed to flow through the space between the walls of the tube S, and the solutions to be exposed are placed in the beaker.

Fig. 19 is from a photograph of the lamp as installed in the Biophysical Laboratory of the Cancer Commissoin of the Harvard Medical School. The lamp is inclosed in a metal case made from a brass tube 6 inches in diameter. It passes through a hole in the table (the mercury cistern A, *Fig. 18,* resting on the shelf below) and is held in an upright position by a light framework which is attached to the case near the top. The brass tube, forming the case, is split longitudinally into halves which are hinged together along one side. One-half only is fixed to the table, the other movable half forming a door. The tube can thus be opened, making all of the lamp accessible.

(To be continued in the August issue.)

Munson Now With Du Pont.

Louis S. Munson, for eleven years chemist for the Ault & Wiborg Co., Cincinnati, Ohio, has resigned to take charge of the production department of the new Du Point Dye Works at Wilmington, Del.

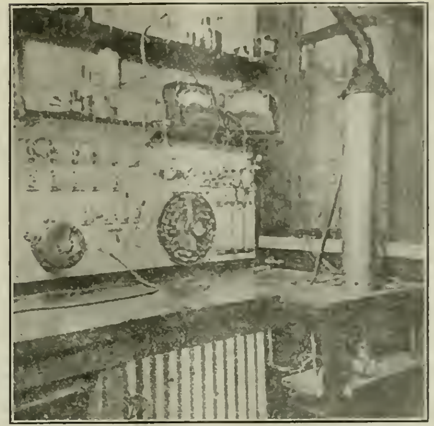


Fig. 19—Installation of Bovie's Lamp at Harvard Medical School.

Fourth Chemical Exposition Will Show Progress

The fourth national exposition of chemical industries will be held in the Grand Central Palace, New York, during the week of September 23rd this year, its advisory committee composed of Charles H. Herty, chairman, Raymond F. Bacon, L. H. Baekeland, Ellwood Hendrick, Henry B. Faber, Bernard C. Hesse, A. D. Little, Wm. H. Nichols, R. P. Perry, H. C. Parmelee, G. W. Thompson, F. J. Tone, T. B. Wagner and M. C. Whitaker. Dr. Bacon of this committee is now head of the Chemical Warfare Section of the National Army and a member of General Pershing's staff.

The coming Exposition will be the largest Chemical Exposition ever held and it will be necessary to use three floors of the Grand Central Palace. The exposition is a war time necessity and regarding it as such each exhibitor is planning his exhibit that it will be of the greatest benefit to the country through the men who visit it all of whom are bent upon a serious purpose—that of producing war materials in large quantities, and constantly increasing this production till the war has been won by the United States and its allies.

The amount of floor space already engaged is greater than last year, the exhibits will be much more attractive, and a movement is under way to show all exhibits of machinery in operation under actual working conditions as they would be found in the field. The products of the chemicals manufactured and as they enter into the world's commerce will be there as examples of what the chemist has produced in America since the world war began.

The South is again sending exhibits from some sections, and Canada, too, is taking the opportunity of presenting the materials it has available for development by the chemist and financier. The Technical and business men all over the country should give heed to these exhibits, since they will show how they can meet the war time need. A section for the glass and ceramic industry has been added, with which the American Ceramic Society is co-operating.

The program for the exposition is in active preparation and will be a series of symposiums on the "Development of Chemical Industries in the United States, notably since July, 1914." This will embrace the period since the beginning of the European war, which, because of its removing the source of supply for our domestic industries, inspired the development of our own chemical industries that, now, when we ourselves have entered the war, are proving so efficient.

The program of motion pictures carries forward the idea of the symposiums, and pictures will be shown of the industries that have developed in so far as they can be with propriety.

The Use of Gas

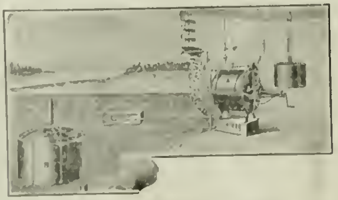
(Concluded from page 286.)

American Sugar Refining Co.; Borden's Condensed Milk Co.; U. S. Rubber Co., and thousands of other factories, homes, stores and large country estates.

Safety

It is worthy of note that never, since the first Tirrill gas machine was made in 1864, has there been an explosion. In fact, it is impossible for an explosion to occur, as one of the chief, exclusive features of the Tirrill "Equalizing" gas machine is that the gasoline is mixed outside of the building, underground and thirty feet away from it. No gas is ever made inside of the building—hence the absolute safety of the machine.

It is for this reason, as well as others, that this machine has the highest approval of the National Board of Fire Underwriters, who have listed it as standard Class A. Insurance rates are never affected by the installation of a Tirrill machine.



A Tirrill Machine Installed

Thus Tirrill "Equalizing" gas machines provide one of the cheapest, most satisfactory and convenient light and heat plants for every possible purpose. For economy of operation, safety, simplicity and duralibility, it is unexcelled. Under all conditions, a standard, uniform, non-poisonous gas is automatically delivered as wanted and no more.

It is perfectly simple and works like a clock; absolutely noiseless in operation. It has no delicate mechanism or complicated parts to get out of order; therefore no expense for repairs.

Furthermore, it is a permanent investment—not an expense. The plant is bought outright for cash or on convenient terms. There are no monthly bills to meet. Machines are made to last a lifetime.

The machine is never affected by weather conditions. It is a finished factory product and positively a most dependable cold-process gas machine. With the blue print and instructions furnished with every machine, any ordinary gas-fitter can easily set the machine up and a novice can operate it.

Economy

From hundreds of actual records, which can be shown, it is found that an average family, using a 25-light Tirrill "Equalizing" gas machine for illuminating, cooking and heating, will not spend more than $18 per year for this purpose.

The gas supplied by the Tirrill machine is even cheaper and better than some city gas. About three gallons of gasoline are used to make 1,000 cubic feet of gas.

Practically every one acknowledges that the brilliantly lighted city home is more attractive in every way than the dimly lighted house. Evening is the real home time. The city man has artificial light provided for him without work, without delay, without trouble, and without danger. Big corporations furnish him with bright light for every room in his house and heat for cooking and warming cold rooms.

This is considered absolutely necessary by him for his comfort and convenience and that of his family. Under no circumstances would he be without it. The price he pays for it is high, yet he believes he gets big value for his money—and he does.

In most city homes coal stoves and coal ranges are no longer in use for cooking and heating rooms. People have become tired of the never-ending care, dirt and ashes; the time and labor necessary to start the fire and keep it going.

In its place for cooking is found a gas range, which supplies heat only as desired, and which is lighted simply by striking a match and turning a key. Any desired degree of heat can be obtained, with practically no effort and which always cooks fast or slow, with the smallest amount of expense and attention.

In city homes, supplied by gas, you do not find some of the rooms shut off in the winter time, as it is so simple, economical and convenient to have every room warm and cozy and the whole house homelike and comfortable.

In a few minutes' time sufficient hot water is ready for dish washing, laundry work, baths, shaving and the many other uses for which hot water is desired.

The Tirrill "Equalizing" Gas Machine is made in standard sizes, according to requirements; price being according to size.

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors. Synthetic Medicinals, Flavors and Perfumes. Explosives, Photographic Developers.

Edited by
THOMAS H. NORTON, Ph. D., Sc. D.

BOARD OF ASSOCIATE EDITORS.

B. R. Armour, American Aniline Products, Inc., New York.

George H. Bruce, LL.B., Keystone Fibre Products Co., Inc., New York.

Edward S. Chapin, Consulting Chemist, Boston, Mass.

B. Flurscheim, Ph.D., Aetna Explosives Company, New York.

John C. Hebden, A.B., Chemical Engineer, Providence, Rhode Island.

C. W. Hill, President of the C. W. Hill Co., Los Angeles

H. Gardner McKerrow, of E. F. Drew & Co., Inc., New York.

Louis A. Olney, M.S., Professor of Chemistry, Lowell Textile School, Lowell, Mass.

Arthur Roberts, President of the American Coal and By-Products Coke Co., Chicago.

H. Dorsey Spencer, B. S., Chemical Patents, 2 Rector Street, New York.

The Manufacture of Naphthols

[The current methods of producing the two naphthols are given in some fullness in a recent issue of *La Revue Des Products Chimiques*. The following translation appeared in *The Dyer and Calico Printer* for December 1, and will be of interest to many now utilizing napthalene derivatives on a large scale. The fact that this class of compounds is not represented in the group of high explosives and that the American output is rapidly increasing leads color manufacturers to employ napthalene derivatives as far as possible in enlarging their plans for new production.—Ed.]

Manufacture of B-Naphthol

The formation of b-naphthol is produced by a reaction similar to that yielding phenol, fusion of the the b-naphthalene sulfonate of sodium with caustic alkali:—

$$C_{10}H_7SO_3Na + 2\,NaOH = C_{10}H_7ONa + Na_2SO_3 + H_2O.$$

According to the temperature of the sulfonation of naphthalene, either the alpha or the beta derivative may be produced. At a low temperature the product is principally the alpha derivative, at a high temperature it is chiefly beta. It is not possible to procure the beta derivative absolutely free from the alpha isomer, and this has to be taken into account in the manufacture of b-napthol. The alpha-sulfonate must first be eliminated, as its presence lowers the value of the final product.

The manufacture of b-naphthol comprises, therefore, three principal operations:—

1. Sulfonation of naphthalene under conditions to obtain the maximum yield of beta-sulfonate.
2. Fusion of the naphthalene sulfonate of sodium with caustic soda.
3. Separation of the b-naphthol and its purification.

The sulfonation is carried out in a kier which can be heated to 200° C., either over the fire or with superheated steam, and the stirrer is kept energetically at work. The kier is charged with 100 kilos of sulfuric acid of 66° Bé, and 100 kilos of finely ground naphthalene are added, the contents being kept above the melting point of naphthalene, 79° C., so that it is melted.

When all the naphthalene has been put in, the temperature is raised to 160° C. and kept thus for three hours, the stirrer being kept going continuously. Then the temperature is raised to 170° C. for an hour and after this to 180° C. for the same period. Water and naphthalene distil over and are collected, from 3 to 4 kilos of naphthalene being recovered. Control samples are taken. The product should be very soluble in water and alkali, and when this period is reached the sulfonation is terminated.

The contents of the kier are run into 2,500 litres of water, and heated with 50 to 60 kilos of lime until the reaction is alkaline. The sulfate of lime formed is separated by filtration and the calcium salt in the filtrate is decomposed with the necessary quantity of carbonate of sodium, about 40 kilos, and concentrated by crystalization.

The sodium salt of b-sulfonic acid separates out and the alpha derivative, being more soluble and in smaller quantity, remains in the mother liquor.

It is a simpler matter, however, to separate out the b-naphthalene-sulfonate of sodium, without the use of lime. For this purpose, the contents of the kier are run as before into 2,500 litres of water and salted with sea salt or sulfate of sodium, or neutralized partially by the addition of about 40 kilos of carbonate of sodium. The sodium salt thus precipitated is filtered in the press and then dried in a vacuum. The yield is from 160 to 165 kilos.

Fusion With Alkali

The general recommendation is to take two parts of caustic soda for one part of sodium naphthalene-sulfonate. This proportion is excessive and makes the process expensive; theoretically, 80 parts of soda are sufficient for 250 parts of sulfonate.

The fusion is effected in a semi-spherical basin furnished with a stirrer. To commence with, 100 kilos of caustic soda are melted in 20 litres of water, the temperature is raised to 200° C. and 160 kilos of naphthaiene-sulfonate of sodium are introduced gradually. The temperature is then raised to 300° C. The fusion is finished in five or six hours. The very liquid mass is run into 2,000 litres of water, and sufficient hydrochloric acid is added to set the naphthol at liberty without decomposing the sulfite of sodium. The b-naphthol is filtered in the press and purified by vacuum distillation. This gives a very pure product. A residue remains which is very rich in tar, about 10% to 15% of the weight of the naphthol.

According to an Agfa patent a very pure b-naphthol, free from the oxidation products formed by fusion in an open vessel, is obtained by fusion under pressure in an autoclave. The autoclave is charged with 46 parts of b-naphthalene sulfonate of sodium and 50 parts of caustic soda solution at 40° Bé., and heated from ten to twenty hours at 300° to 330° C. The b-naphthol is separated as already described.

B-naphthol is usually sold in pieces or in powder. It melts in a pure state, at 123° C., and distils at 285°-286° C., slightly decomposing.

The cost of production in France is estimated at 80 to 85 francs the 100 kilos. With cheaper raw materials, the German works can produce it at 70 francs and can compete in France, in spite of the 15 francs per 100 kilos duty.

The sale price was 110 francs per 100 kilos before the war. B-naphthol was sold at 16 francs per kilo in 1916, and there is now a considerable margin between the cost and the sale price.

B-naphthol is used in color making, either directly, as in the case of the azo colors, Meldola's Blue, and others, or after transformation into various sulfonic acids. It is largely used in dyeing and printing and for the development of p-nitraniline and other azo colors on the fibre.

It is also used in making pharmaceutical products, benzo-naphthol for instance, and for synthetic perfumes, Neroline, Yara-Yare and others.

Preparation of A-Naphthol

An analogous process to that adopted for b-naphthol is used, the alkalien fusion of a-naphthalene sulfonate of sodium.

About 2 parts of sulfuric acid of 66° Bé. are heated, not about 80° C., with one part of naphthalene to produce the a-sulfonate. The sulfonating kier already described is charged with 175 kilos of sulfuric acid, and, little by little, with constant stirring, 100 kilos of finely ground naphthalene are added, keeping the temperature above 50° C. When all the naphthalene is introduced, the temperature is raised to 80° C., and this point is not passed. The naphthalene is transformed into monosulfonic acid, and the operation is controlled by testing samples for solubility. When the greater part of the naphthalene is transformed, the contents of the kier are run into 2,500 litres of water, and the a-sulfonic acid sodium salt is separated either by partial neutralization with carbonate of sodium, or by precipitation with sea salt or sulfate of sodium, or by liming, which takes much longer. By alkaline fusion at 320° C., the sodium salt gives naphtholate of sodium. The a-naphthol is isolated exactly as described for b-naphthol, and distilled in a vacuum.

A-naphthol can also be prepared by hydrolysis of the salts of a-naphthylamine. For this purpose, 40 kilos of sulfate or hydrochloride of a-naphthylamine are heated at 200° C. for four hours in an autoclave with 200 litres of water. The following reaction occurs:—

$$C_{10}H_7NH_2HCl + H^2O = C_{10}H_7OH + NH_4Cl.$$

After cooling, the a-naphthol, which sinks to the bottom of the kier, is separated and purified by vacuum distillation. The ammonia is recovered by adding lime to the mother liquor and distilling it.

It will be noted that this process is the inverse of the previous one; it seems to be a more expensive method than that depending upon alkaline fusion, but gives a much purer product.

A-naphthol melts at 94° C., and distils at 279° C. It is sensitive to the action of the air, and turns brown eventually on exposure. It is used in the manufacture of azo colors, indophenol and naphthol Yellow S.

Naphthol Yellow S

In view of the importance of this color, which is not manufactured in France, it may be useful to give the formula for its preparation. Twenty-five parts of finely divided a-naphthol are dissolved in 100 parts of fuming sulfuric acid. This is done in a kier, provided with an energetic stirrer. The temperature is raised slowly to 120 C. to form the bisulfonic acid of a-naphthol. It is very important that the transformation should be complete, as otherwise the final product will contain dinitro-naphthol. The reaction is easily ascertained by taking successive samples; a little is diluted with water and heated with nitric acid; if the sulfonation is complete, there should be no yellow precipitate showing the presence of dinitro-naphthol.

If there is a precipitate a little more anyhydrous acid is added to the contents of the kier. When the absence of precipitate shows that the reaction is complete, the contents are allowed to cool and poured on 250 parts of ice, and then to the trisulfonic acid solution thus obtained 60 parts of nitric acid of 40° to 42° Bé. are added, and the temperature is raised to 50° C. and kept at this point until nitration is complete. The mass is then left to cool for twelve to twenty-four hours and filtered through sand. It is washed in salt water, then re-dissolved in water and neutralized with carbonate of sodium, and the dyestuff is precipitated in the form of sodium salt by the addition of salt. This is collected by filtration and dried with the usual precautions.

Naphthol Yellow S. is an important coloring matter for wool and silk. Dinitronaphthol, Martius Yellow, is obtained by preparing the naphthol-disulfonic acid, and acting upon this with nitric acid. This can also be produced by treating diazo-naphthalene with nitric acid. The diazo-naphthalene is itself prepared by the action of nitrite of sodium on a-naphthylamine. This coloring matter is used for tinting alimentary products, such as macaroni, although this use seems to be objectionable.

German Patents on Coal-Tar Colors

At the recent meeting of the National Association of Cotton Manufacturers in Springfield, Mass., a strongly worded resolution was adopted, calling for a confiscation, during the war, of German patents on dyestuffs which have not yet expired. The resolution was as follows:

"Resolved, That the National Association of Cotton Manufacturers earnestly urges the United States Government to take immediate steps similar to those taken by the Government of Great Britain to confiscate for the period of the war certain patents on dyestuffs held in this country by subjects of the German empire, thus providing for manufacture by reputable dye concerns, by a system of lease or other adequate method of control, which at the close of the war will assure fair compensation to the present owners of the patents."

There would seem to be no question but that the time has arrived when active steps should be taken to enable our expanding dyestuff industry to utilize the patents on several important groups of artificial dyestuffs, taken out by German inventors, since the beginning of the century. American dyers had become accustomed to these colors, especially to the various algol and indanthrene dyes, hydron, blue, immedial green and allied sulfur dyes, before the war and learned to value the exceptional fastness and ease of application. But a few years must elapse, in most cases, before the patent rights expire and the manufacture in the United States will be free to all. There would be, however, a most manifest advantage if our American color firms could make themselves so familiar now with the details of production that when the patents expire, after a return to normal conditions, the manufacture on a large scale, with a minimum cost of production, can be established without loss of time.

In this connection it is worthy of note that several leading American companies have secured lists of the German-owned patents which have been taken over by British firms since the beginning of the war. Among these are not a few dyestuff patents. There is little doubt that if the way is free, the production of the more important members of this group will promptly be established upon American soil.

Copper Compounds of Ortho-Oxy-Azo-Dyestuffs

The copper compounds of various ortho-oxy-azo colors, discovered recently by Wuth and Jagerspacher of Basel, have attracted attention on account of their vivid character. Dr. Gadient Engi, of Basel (Am. Pat. 1,245,694, of Nov. 6, 1917) shows that a certain class of these new colors is susceptible of further combination with chromium, and that the resultant products manifest a notably increased resistance to fulling and to potting. This class includes dyes with a free carboxyl group in the Diazo compound or a hydroxyl group and a carboxyl group in the component joined with it.

The results are obtained by dyeing the colors in question on chromium mordanted wool, or by using a bath containing chromatis or other soluble chromium salts, or by treating dyeings subsequently with the same chromium compounds.

The process is likewise available for dyeing and printing cotton, producing very fast tints.

The copper dyes in question are obtained chiefly from o-amino-salicylic acid, and its para derivatives (NO_2, Cl, SO_3H);

4-oxy-3-amino-1-benzoic acid;

1-amino-2-3-oxy-naphthoic acid;

2-amino-phenol-4-sulfonic acid;

2-amino-6-nitro-phenol-4-sulfonic acid;

3-amino-5-nitro-4-cresol; 2-amino-4-nitro-phenol;

1-amino-2-naphthol-4-sulfonic-acid.

These are diazotized and coupled with a great variety of components, phenols, amines, carboxylic acids or their derivatives, especially the sulfonic acids, to form dyestuffs.

The patent tabulates the results obtained from 70 of these mono-azo and disazo colors, after combination with copper, when dyed alone or after being subsequently chromated.

Ault & Wiborg Have Fire.

Ault & Wiborg, chemical manufacturers, of St. Bernard, Ohio, suffered considerable loss recently when fire destroyed one of the new frame buildings of their plant. The cause of the fire is undetermined.

By-Product Coke Plant of 330 Ovens.

A large by-product coke oven plant of 330 ovens will be constructed at Swedeland, Pa., by the Rainey-Wood Coke Co., and the Alan Wood, Iron & Steel Co., which have combined in order to carry out this project. It is expected to have the plant in operation within fourteen months. A complete by-product recovery plant for the purpose of furnishing ammonium sulphate and toluol to the U. S. Government will be a feature of the works.

An American Nomenclature for Synthetic Dyestuffs

The claim is advanced that the position of the American coal-tar color industry would be vastly strengthened if all dyestuffs made regularly in this country should be given distinctly American names, instead of the designations originally applied by the foreign inventors, or currently employed by foreign manufacturers.

John Campbell & Co., of 75 Hudson St., New York City, have issued a pamphlet on the subject, in which the argument is elaborated at some length. The presentation of the idea is quite forcible, as will be seen from the following extracts:

The development of the American Dyestuff Industry during the past few years, dating from the time of the beginning of the great world war, is a record of achievement that well deserves an enviable place in the annals of American business. The reason for our neglect of this industry during the many years prior to the war is an open question admitting of many different, well-founded opinions. Be the cause what it may it is a universally recognized fact that the entire world depended upon Germany for aniline colors and all nations were almost wholly and surely pitifully unprepared to meet the conditions brought about by the shutting off of this source of supply.

The American manufacturer has demonstrated to the world in a few short months that he is capable of building up a self-sustaining dyestuff industry. He has produced most of the simple colors and is now bringing out the more difficult colors; this the American manufacturer has done in the face of difficulties and obstacles that to a less determined people would have been deemed insurmountable.

Time, patience and a high degree of technical knowledge, as well as expensive equipment, are essential to the production of synthetic colors. The American manufacturer with rare faith in the ability of the American chemist has willingly invested his capital, cheerfully paid for the costly research work and necessary experiments and his faith in American brains has been rewarded by the joy of creating a great industry.

But is this great industry, representing even in its infancy an investment of many millions of dollars and created by countless days of effort, worry and anxiety while it was passing through the experimental stage, to be a permanent monument to the achievement of American business and chemical genius, or is it to be but a spasmodic industry, only bridging the time of the duration of the war until the German dyestuffs manufacturers cease making explosives and concentrate their efforts to the recapture of the business, the monopoly of which they so long enjoyed?

This question is a momentous problem with ramifications entering into every branch of American commercial life. We will devote a little space to the consideration of but one aspect of this problem and discuss briefly the influence of nomenclature, as the Germans have practiced it, upon the dyestuff industry.

It seems that a myth went up and down the earth a few years ago, that the Germans were a race of supermen. When a man or a cult representing a group of men claims superiority in any special line of thought or endeavor and constantly reiterates that claim, the world either dismisses them from its mind as bores or eventually believes them. The Germans as a nation admitted their superiority and the world chose to believe them.

The German nation has applied science to industry as has no other people. Even the influence of therapeutic suggestion, its recognized power to shape and dominate the opinion of others, has not been overlooked by them, but has been applied to business. The recognized power of this suggestive art to shape and dominate the thought and opinion of others has been systematically used in their various forms of propaganda. The world has been told from time to time that the production of coal-tar dyes was a peculiarly German institution; that they could not be made by other countries. This statement was accepted as a fact in the days preceding the war, but when the source of supply was shut off the American manufacturer soon got busy and punctured this German myth. We are producing most of the widely used colors which we had been told were impossible of production outside of German factories, and our manufacturers are now actually bringing out some of those more difficult colors which it has taken German chemists many years to produce.

But it is in the naming of their colors that the German manufacturers have displayed real sagacity and genuine business acumen and it is with this weapon of nomenclature that the American manufacturer must fight back. Each German firm as it produced various colors naturally christened them with names. At first each name really described a shade or color or indicated to which chemical family or group the color belonged. Later this custom was changed; an arbitrary, copyrighted word being given as a name which identified the color as a product of a certain German factory. Where several factories were producing the same shade or color, each factory gave its own special name. For instance, several German firms were making the same direct cotton color, a bright blue shade: one manufacturer called this shade "Diamine Blue," another gave it the name of "Benzo Blue," while other names used were "Chicago Blue," "Oxamine Blue," etc.

Now the American consumer will never willingly put himself in the position he occupied when the war shut off the supply of German colors. He realizes the necessity of having a dependable source of supply at home, and the only way this can be done is for the consumer of dyes to support the American dyestuffs manufacturer. No American mill man should use the German trade words for the name by which he has known colors in the past; to do so would be playing right into the hands of the German business propagandist. Therefore, let us be loyal to everything American, and among other things designate the American colors by their American names.

The project is certainly patriotic. Is it practicable?

We must consider the psychology of the consumers of colors. The great majority of these consumers are familiar with but a very brief range of colors, and are accustomed for years to foreign designations for these colors. Their knowledge of the chemical composition of dyestuffs is usually limited and dependence is placed chiefly on the very carefully drawn-up directions for using a dye as provided by the maker.

If such consumers are to be made familiar with an entirely new nomenclature for substances which they have handled for years, the operation should be made as simple as possible.

It would seem desirable in all such cases to associate, for a term of years at least, new American designations with those current hitherto for the foreign wares. When using a new, distinctively American name for a dye, on the label of a container or in a manual for directions for dyeing, it would be an easy matter to add in a parenthesis:

"Manufactured abroad under the names of ——, ——, etc."

Thus, a well-known azo dye has been manufactured in this country for a number of years and sold to the American trade under the name of Alizarol Yellow. If all packages of this color were labelled: ALIZAROL YELLOW, an American-made color (manufactured abroad under the name of Mordant Yellow GD, GS, R[B], Silicin Yellow D [K], Fast Chrome Yellow R [A], Alizarin Yellow G [S], Anthracine Yellow BN [C]), it would be comparatively easy for all users to associate the tinctorial value with the names to which they have been accustomed in the past. As a matter of fact, in the case cited above, some six additional titles could be added to make the list complete. The symbols in brackets indicate the manufacturing firms.

Such a system of labeling would enable consumers to act intelligently and easily in the case of rival colors. They would know at the outset that, chemically speaking, there is practically no difference between the dyes in question. The process of dyeing is the same in all cases. Minor variations in tint are due to blinding or intentional modifications in the operations of manufacture.

The main point is the exact amount of coloring matter available in a unit of weight, and the question of price will hinge upon this factor.

We should go a step farther than the contention of the firm quoted above. American-made dyes may properly receive distinctively American names, but all packages of the same should carry as clear and definite a statement regarding the strength as is now the current practice for synthetic indigo.

If this practice is made universal among American manufacturers of dyes, it will force their foreign competitors to adopt the same method. This will simplify enormously for consumers the problem of establishing actual competitive values between domestic and foreign products as well as between rival domestic producers.

This brings us, therefore, face to face with the problems of standardization. The position of this journal on this subject is well known.

"NOW MADE IN AMERICA"

This the True Meaning of

ALMARIN

BRILLIANT MALACHITE CRYSTALS
RHODAMINE B & B EXTRA
CRYSTAL VIOLET 6 B A S EXTRA
BRILL. FUCHSINE CRYSTALS
Guaranteed 100% Soluble

BRILL. SAFFRANINE G EXTRA
DIAZO BORDEAUX F F
CHRYSOPHENINE G S
DIAMINE FAST LIGHT YELLOW F F
DIAMINE FAST PINK 8 B S
DIAMINE ROSE G S
BENZO FAST SCARLET 4 B A S
BENZO FAST SCARLET 8 B A S
Fast to Acid Lead Dyeing Union Colors
BENZO FAST RED 8 B A L
BENZO PURPURINE 10 B S AND 4 B S
BENZO SKY BLUE 6 B A S (stands copper test)
LANA FUCHSINE S L AND 6 B
ACID BRIGHT GREEN 2 G
ACID BRIGHT BLUE 2 G

in preparation

SULPHUR NAVY BLUE & OLIVE DRAB
ALIZARINE NAVY BLUE & OLIVE DRAB
Government Standard

DI-ETHYL ANILINE Guaranteed 99% Pure or Better

Prices for Spot or Contract "From One Pound to a Million" and Samples Cheerfully Furnished

The Almarin Company

MANUFACTURING CHEMISTS

TELEPHONE: CORTLANDT 377

Singer Building, NEW YORK

18 Years of Chemical Progress

The Recovery of Potash

(Continued from page 290.)

lected ran at first from 5% to 6%. We have succeeded in bringing this up to an average of 9% or 10% and occasionally get as high as 14%. This seems to be about the limit for our style of treater but by using the principle of selective precipitation, there is no reason why it should not be brought up to 15% or 20%, depending on the richness of the raw mix.

Pure Potash Salts.

We have just begun to develop the possibilities of the production of pure potash salts but at present our market is almost entirely in the fertilizer industry. We have shipped to a large number of fertilizer manufacturers and our material has met with very general favor. It is particularly liked because of its fineness and physical condition. It also has some negatives and must be used with discretion. The lime content will cause reversion of the soluble phosphoric acid in mixed fertilizer if the material is added in excess. For this reason it has been found undesirable to use more than a certain proportion in fertilizer mixtures and it cannot be used satisfactorily to make very high potash goods. If the treater dust is very low in potash, it is unsatisfactory even for the manufacture of low potash goods. At the present time fertilizer manufacturers are not inclined to be critical of potash in any form but it is evident that when German potash is back on the market, a material containing less than 8% or 10% is not likely to be looked on with much favor.

Prospective Markets.

It is quite possible that a market for this material could be developed, selling direct to the farmer. It contains potash which is necessary to plant growth and lime which is necessary on most soils as a sweetener. The recombined potash contained in it is slowly soluble in soil acids and, therefore, gradually available to crops as needed. There are, however, practical difficulties in the way of developing this direct market. A vast amount of educational work would be necessary, the demand would be seasonable, and under present standard regulations for the sale of fertilizer, no credit could be obtained for the recombined or slowly soluble potash. It is probable that in the future this last objection may be overcome. A movement to this end would have the backing of Government experts but would necessarily be slow because of the number of people to be converted. It should be borne in mind that German potash has heretofore monopolized this market and all trade practices have been based on behavior of their material.

I have mentioned the fact that the recombined potash can be made soluble by long boiling, by digestion under pressure or by treatment with dilute acids. All of these methods are commercially feasible if the potash is sufficiently concentrated but it is obviously not profitable to treat a great volume of dust in order to recover a very small percentage of potash. For this reason concentration of the potash during collection should be a preliminary to any system of treatment for the recovery of the recombined potash.

Ideal Procedure.

Based on our experience and experiments, I would suggest the following as the ideal procedure in the collection of potash:

First, pass the gases at a relatively high velocity through a preliminary dry precipitator. The purpose of this would be to take out from 50% to 75% of the coarsest dust, which should then be returned to the kilns. With this dust would also be taken out a certain proportion of the potash, but this proportion would be small relative to the dust and would not be entirely lost, as it would pass again through the kilns.

The gases should not pass through a water film treater where the balance of the dust and practically all of the otash would be collected. The solution obtained here would be circulated through the water film treater until nearly saturated with potash salts and would then be evaporated by the waste heat of the gases for the recovery of these salts. The sludge containing the insoluble material would be treated in digesters at 100 lbs. pressure for one hour in order to liberate the recombined potash. It would then be filter pressed and the solution containing the potash would be combined with the original solution and evaporated. The filter press cake would be returned to the kilns. The cost of such a plant under present conditions would be in the neighborhood of $150,000 for a 3,000 bbl. plant.

Estimating Potash Recovery.

For the benefit of those who may wish to figure on their own conditions, I give the following method of calculating the probable recovery of potash:

Let A equal % potash in raw mix.
B " % potash in clinker.
C " % liberation $= \dfrac{600A - 380B}{600A}$
F " lbs. of potash recombined per bbl. clinker = .7 to 1.5 depending on fuel consumption and per cent. ash in coal.
P " % potash precipitated in treaters.

Assume 600 lbs. of raw mix actually used to make 1 bbl. of clinker, then: Lbs. of otash entering kilns per bbl. of clinker equals 600A.

Lbs. of potash volatilized in kilns per bbl. clinker equals 600AC.

Lbs. of water soluble potash entering treaters per bbl. clinker equals 600AC — F.

Lbs. of water soluble potash collected in treaters per bbl. clinker equals (600AC — F) x P.

Potash Prices May Hold Up.

At present prices for potash, almost any kind of recovery is profitable but there is no assurance as to how long present prices will continue, and the great question is whether recovery can be profitably continued after the war is over.

It is the trade custom to sell potash material on a basis of the units of pure potash contained; a unit being 1% of a net ton or 20 lbs. The present market price for agricultural potash is in the neighborhood of $5.00 per unit, whereas pre-war prices fluctuated between 60c. and 70c. per unit. In the opinion of those best acquainted with the industry, the price of potash will not drop to its former figure immediately on the close of the war, but it is thought likely that the price will remain relatively high for a number of years.

The cost of collecting potash at Security is now running about as follows:

Collection, including labor, power, repairs and laboratory	$0.14 per unit of potash
Packing and shipping	0.08 per unit of potash
Total operating cost exclusive of depreciation, royalty and salt addition	$0.22 per unit of potash

The cost of the salt addition is about $0.25 per unit of potash, but this is not a necessary element of cost and can be omitted whenever price conditions become such as to give an unsatisfactory margin of profit.

These figures cannot, however, be applied to other plants because nearly all the elements of cost are constant per day irrespective of the amount of potash recovered. The following figures taken in connection with the calculated recovery will give a basis for estimating cost in any particular case:

Labor required for operation—1 foreman (who can also supervise packing and loading) and 1 or 2 operators per shift; about $12.00 per day.

Laboratory—1 additional chemist, say $4.00 per day.

Power—1,300 kw. hours per day for 3,000 bbl. plant, based on dry collection plant—about $12.00 per day. A wet treater would require additional power for pumps to handle solution.

Cost of operating digesters and evaporators or of packing and loading dry dust not included above.

Cost of adding salt to raw mix will run about 2.2c. per bbl. of clinker at present prices for salt. It would be reduced to about 1.6c. per bbl. in normal times.

Cost Calculations.

The following is an example of the methods of calculating probable costs and profits:

Assume a 3,000 bbl. plant; .75% potash in raw mix—70% liberation when using 1% salt; 10% ash in the coal and 90 lbs. of coal used per bbl. of clinker; 0.9 lb. potash recombined per bbl. of clinker; 90% collection in treater.

Using selective precipitation and water film type of treater, also treatment of slurry for liberation of recombined potash and recovery of pure potash salts by crystallization.

Lbs. of total potash collected in treater per bbl. of clinker equals (600 x .0075 x .7 x .9) or 2.835 lbs.

There will be a loss of about one-half of the potash collected in the preliminary treater and returned to the kilns. This will amount to about 15% of the total collected. There will also be some loss in the digesting and crystallizing process which, to be conservative, we will assume to be 10% of the potash so treated. On the other hand, there is no loss through recombination since the digesting process renders this recombined potash water soluble. Hence net water soluble potash recovered per bbl. of clinker = 2.835 x .85 x .90 = 2.078 lbs.

This potash would be in the form of relatively pure crystallized salts and there would be no question as to its salability.

Operating costs and profits would work out about as follows:

Operating cost—

Labor	$ 27.00 per day	.0090 per bbl. clinker
Power	25.00 per day	.0083 per bbl. clinker
Repairs	8.00 per day	.0027 per bbl. clinker
Laboratory	120.00 per mo.	.0014 per bbl. clinker
Salt addition		.0220 per bbl. clinker

	Present Price.	Assumed After War Price.
Sales price per unit of potash	4.50	$1.00
Value of potash collected by bbl. of clinker	.4675	.1039
Operating cost per bbl. clinker	.0434	.0434
Operating profit per bbl. clinker	$0.4241	$0.0605
Operating profit per year based on full operation of cement plant	$458,038	$65.340

This result does not allow for depreciation, royalty or loss due to part time operation of cement plant.

Effects on Operation of Plant.

No doubt the first thought of every cement manufacturer will be as to the effect of potash recovery on the operation of his cement plant. There is a possi-

HELP WANTED

PRACTICAL EXPERT wanted in manufacture of food products; one knows how get results from raw materials; give experience, reference, etc. C., c/o Chemical Engineer.

MECHANICAL AND CHEMICAL ENGINEER—A manufacturer wants a man with above qualifications to help develop his present method of production; state detail experience, age, and salary expected. Write Engineer, Room 611, World Building, New York City.

WANTED, ANALYTICAL CHEMIST FOR FERTILIZER FACTORY. A fine opportunity for an energetic and ambitious young chemist understanding machinery and with knowledge of heat engineering and practical chemistry. Write "V. C.," c/o Chemical Engineer.

CHEMIST, with Belgian diploma and experience in sugar derivatives (sugar, alcohol, and perfumes), and Professor of Spanish and French, wants position; without experience in other branches of chemistry; accept position as assistant. Write to G. A., 338 West 45th St., New York, N. Y.

bility of its affecting output, fuel consumption and quality. As to these points, our experience at Security should be of interest.

The effect on output has been negligible. For the first few weeks of operation at the potash plant we had some trouble with our drafts and output was decreased. Following this came a period when it surpassed all previous records. This, however, we know to have been due to other conditions and to have no direct bearing on the potash plant.

Fuel Consumption Reduced.

In our case, the addition of the potash plant has reduced our fuel consumption. For 5 months in 1916 without the potash plant our fuel consumption averaged 96.4 lbs. per bbl. For 5 months in 1917 with the potash plant, it averaged 87.0 lbs. per bbl. This has been brought about through more careful attention to the temperatures at the back end of the kiln. Whereas these temperatures at one time fluctuated wildly, they are now almost perfectly uniform and average much lower.

There is no evidence that the addition of the potash recovery plant has had any effect whatever on the quality of our cement except that there has been a tendency toward harder burning since we have found that harder burning gives a better recovery of potash. Some question has been raised as to the possible effect of the salt addition on quality, as it is known that the presence of an excessive amount of alkalies in the clinker may under certain conditions cause setting troubles. Strange as it may seem, however, we have found that the addition of 1% salt to the raw mix results in a lower percentage of total alkalies in the clinker than when no salt is added. Obviously if the salt does not go into the clinker but is practically all volatilized and passed out with the gases, it can have no possible effect on quality. As a matter of fact, we have experienced no quality troubles which could in any way be traced to the use of salt and the fact that a Western plant, as before mentioned, is reported to use regularly a raw mix containing as much as 5% salt is also evidence that this material is not injurious.

No Change in Manufacturing Methods.

I would emphasize here the fact that the collection of potash does not involve any change in present methods of manufacturing cement. It is simply the recovery of a by-product that is now going to waste and is in line with present tendencies towards the conservation of raw materials and increased efficiency in manufacturing.

I have spoken of the possibilities through the use of feldspar and other high potash materials. There are only a few existing cement plants which can do this to advantage as not only must a regular supply of good feldspar be close at hand but the limestone used with it must be high in lime and there must be, either in the limestone or elsewhere, a supply of alumina or iron oxide to offset the high silica of the feldspar. Under such favorable conditions, it is possible to get a mixture containing as high as 2.5% of potash and a recovery of 7.5 lbs. of potash per bbl., equivalent at present prices to $1.875 per bbl. In other words, under very favorable conditions the potash may easily become the principal product of the plant in value and the cement be relegated to the position of a by-product.

Recovery Pays for Itself in Year.

In conclusion I would say that the Security Cement & Lime Company has been very well repaid for its venture into this comparatively new field. Our gain by acting promptly and thus reaping the full benefit of high prices has far more than offset the loss through our failure to get the benefit of others' experience and the very best type of installation. We have had many anxious moments and much hard work in bringing the enterprise to a successful conclusion, but all is well that ends well. Now with the cost of our plant more than returned to us from the profits of the first year's operation and with our profits from the sale of potash in excess of those from the sale of cement, we feel that our efforts have been abundantly justified.

Spun Glass in Endless Lengths.

In Venice, for many years, the art of glass spinning was fostered, until this city became known for the great beauty of the ornamental objects which it put on the market.

There have always been shortcomings in the work, due to the fact that glass thread could be spun only to the length of the circumference of the wheel on which it was worked, and this was never more than eighteen feet.

This difficulty has been overcome by an American manufacturer, who can make spun glass thread into endless lengths, and put it on spools as is done with ordinary threads. This enables a multitude of objects to be made, that could not be made before. The threads of glass can be made in all colors, giving a world of brilliancy.

Because of being fireproof, spun glass curtains, for fireplaces and as draperies and hangings in theatres, hotels and public places, are unequalled. Many wonderful and beautifully hued millinery trimmings are made from the braided glass. The glass thread can be interwoven with silks, cottons, wire, etc., giving an endless variety of combinations. Dancing dresses for stage people have remarkable novelty.

Technical Uses.

Probably the largest field of use will be in the technical and engineering fields, where it already has a foothold. Because of the difficulty of working constantly under the extraordinarily strong light of the moving picture studios, the producers have taken to glass-woven cloths as light diffusers, with splendid results. As absolute non-conductors, glass plates for storage batteries will give longer life than present day plates. For insulation of electric wires, instruments, etc., the glass thread can be used. As an example of its non-conductivity, power house workers have had the soles of their shoes bottomed with spun glass plates, to avoid shock. For the filtration of acids, glass plates are excellent.

There are a world of uses for this new product, and L. Reusche, of the Reusche Company, who manufacture the product, states that each field will be developed thoroughly with the thought of giving general distribution of its many advantages.

A Special Filter Paper for Every Filtering Need.

Some factories still depend upon a rule-of-thumb or guess-work system of choosing filter papers for the various filtering processes they use in their manufacture, and fail to get maximum efficiency from their work.

While the average factory ordinarily uses the filter paper that approaches the best possible, there are just the slightest shades of difference between the many needs, that only the expert filter paper man can decide on the right grade to use.

H. Reeve Angel & Co., of 7 Spruce Street, New York City, are experts in the advisement of factories on the proper papers to use because of their many years of service in the field.

The following brief classification of filtering needs and papers to meet them has been made by them and gives only a slight idea of the possible differences among papers.

Qualitative Papers.

1. For general work.
2. For fine precipitates; very rapid.
3. Heavy; for the finest precipitates.
4. For gelatinous and large particle precipitates; extremely rapid.

Single Acid Wash.

1. For fine precipitates; very rapid.
2. For gelatinous and large particle (not free) precipitates; the most rapid filter paper made.

Double Acid Wash.

1. For general quantitative work.
2. Very rapid; not for use with fine precipitates.
3. For extremely fine precipitates; for use with or without vacuum.
4. Lower ash than above mentioned for most exacting analyses.

This only gives a comparative idea of the classifications made by the H. Reeve Angel company. Representatives of this firm are always ready to give advice to any manufacturing and practicing chemist as to the best papers to use for the particular work he is specializing in.

New London Chemical Co.

The New London Chemical Co. has been incorporated with a capital of $50,000 at New London, Conn., to manufacture chemicals and allied products. The incorporators are: Bert W. Flanders, Ira M. Comstock and H. E. Harris, New London.

Will Manufacture Coke and Chemicals.

With a capital of $100,000 the Chicago Coke & Chemical Co. has been incorporated at Portland, Me., to operate a plant for the manufacture of chemicals, coke, iron, etc. Incorporators are: P. B. Drew, C. G. Trott and D. F. Drew, Portland.

New Dyestuff Manufacturers.

To engage in the manufacture of dyestuffs, the Colonial Aniline Works has been incorporated with a capital of $10,000 at Monticello, N. Y., by P. S. Glickstein, W. and C. Lowenthal, Brooklyn, N. Y.

Earle Chemical Co.

Chemicals and allied specialties will be manufactured by the recently incorporated Earle Chemical Co. of Wheeling, W. Va. The capital is $50,000 and the incorporators are: R. I. Runner, E. H. Draker, Eugene Hill, Raymond Sypher and C. Rader, of Wheeling.

DESIGNS FOR CHEMICAL BUILDINGS
AND COMPLETE EQUIPMENTS
MILL ENGINEER
Frank Sutton
80 BROADWAY, N. Y. C.
Established 1897 Tel. Rector 960

CHEMICALS
COLORS
MINERALS

For the following Trades:

RUBBER OIL CLOTH
PAINT PAPER
TEXTILE PRINTING INK
POTTERY LEATHER

KATZENBACH & BULLOCK CO.
New York Trenton Chicago
Boston San Francisco

DISTILLATES

News Notes of Chemical and Allied Industries

Permutit Co.'s New Home.

The Permutit Co., of New York City, manufacturers of water softening devices, have moved from 30 East 42nd street into their new offices at 440 Fourth avenue.

New Building for General Chemical Co.

At Marcus Hook, Pa., the General Chemical Co. of New York is about to begin the construction of a new one-story service building at a cost of $100,000.

Bond Chemical Co.

Chemicals and allied products will be manufactured by the newly incorporated Bond Chemical Co. at Camden, N. J. The capital is $125,000 and the incorporators are John J. Finney, Joseph Mallon and F. M. Wick, Camden.

Western Chemical Products Co.

The Western Chemical Products Co. has been incorporated with a capital of $25,000 at Vernon, Cal., to manufacture chemicals, by G. W. Marchand, Long Beach, W. T. Moore, Long Beach, and T. C. Yeager, Canton, O.

Prof. Loy Forsakes Chair for Business.

Prof. S. K. Loy, professor of chemistry at the University of Wyoming, has tendered his resignation to enter the commercial world as chief chemist of the Midwest Refining Co., Casper, Wyo.

To Remodel Laboratory.

At an estimated cost of $20,000 the Bureau of Yards and Docks, Navy Department, Washington, D. C., will remodel its chemical laboratory at Indian Head, Md.

Basic Phosphate Fertilizers.

At Birmingham, Ala., the National Basic Fertilizer Co., has been incorporated with a capital of $137,000 to manufacture basic phosphate fertilizers. The incorporators are C. E. Elgin, Searls, Ala., J. W. Lowman, Albany, N. Y., and W. S. Oglesby, Searls.

Butterworth-Judson to Rebuild Plant.

Plans are being rapidly completed by the Butterworth-Judson Corp. for the reconstruction of its plant in Avenue R, Newark, N. J., which was recently destroyed by fire with an estimated loss of $200,000.

Grasselli's New Acid Plant.

Work has been begun on the new local acid manufacturing plant of the Grasselli Powder Co. at Cleveland, Ohio. The new plant represents an investment of about $1,000,000.

To Manufacture Potash Salts.

J. B. Speed & Co., Louisville, Ky., is planning the expenditure of $100,000 for the erection of a potash manufacturing plant at Lockland, that state.

To Manufacture Cement Products.

Cement products will be manufactured by the recently incorporated Waterproof Cement JProducts Co., which has been organized at Norfolk, Va., with a capital of $100,000.

Scarcity of Dyestuffs in Java.

A recent report from Java indicates that there is a great scarcity of all kinds of dyestuffs there. Manufacturers interested can obtain information as to trading facilities from the Bureau of Foreign and Domestic Commerce, Washington, D. C.

Will Help Furnish Sinews of War.

H. Koppers Co., Pittsburgh, Pa., will have charge of the erection of a $110,000 plant for the production of toluol from gas which the U. S. War Dept. will locate near the works of the New Haven Gas Co., New Haven, Conn.

A Correction.

In our June issue we chronicled the good fortune of the Duriron Castings Co., New York City, in securing the services of Mr. Arthur Hough in the capacity of consultant. The spelling of Mr. Hough's name, however, should have been as it appears herewith, and not "Howe," as given in the news item referred to.

Fifty New Coke Ovens Building.

A battery of twenty-five Wilputte coke-ovens is to be added to the original twenty-five with which the Algoma Steel Corporation had planned to enlarge its plant at Sault Ste. Marie, Ontario. This makes a total of fifty new ovens now in process of construction at the plant, and it is expected that these will be ready for operation before the first of the year.

Redwood Tanks for Storing Fuel Oil.

Of extreme interest to users of tanks comes the news that at the behest of a concern whose name is withheld, the Acme Tank Co., New York City, has recently completed the installation of a battery of twelve 6,000 gallon redwood tanks for the storing of fuel oil. Although steel tanks are customarily employed for this purpose, the difficulty of obtaining the metal led the purchaser to cast about for a suitable substitute, with the result that, after careful consideration, it was decided to employ tanks built of pure California redwood, which the Acme Tank Co. specializes in.

NEW PUBLICATIONS

"Mining and Concentration of Carnotite Ores."

"Mining and Concentration of Carnotite Ores" is the title of Bulletin 103, recently issued by the Bureau of Mines, Department of the Interior, the authors being Karl L. Kithil and John A. Davis.

In a review of the work on radium by the Bureau of Mines, Van H. Manning, director, says:—"In 1912 the Bureau of Mines had its attention called to the value of the carnotite ore of Colorado and Utah as a source of radium and to the need of investigations being made to prevent waste of low-grade carnotite, to enable the miner to receive a better price for his product, and to insure the profitable recovery of the highest possible proportion of the radium in the ore. The need of comprehensive research was increased by the carnotite deposits being situated on public lands and constituting the largest known supplies of radium ore in the world. Fortunately the Bureau was able to interest Dr. James Douglas, of New York City, and Dr. Howard A. Kelly, of Baltimore, Md., who wished to procure a supply of radium for use in the treatment of cancer in hospitals with which they were connected. The suggestion was made that they form a radium institute. Accordingly, the National Radium Institute was incorporated for the purpose of studying the best methods of producing uranium, vanadium and radium, and the mining and concentration of ores from which these products may be obtained for use in radium therapy.

"Subsequently, at the suggestion of the institute, a co-operative agreement was made under which the Bureau of Mines undertook to provide the services of skilled chemists and mineral technologists for the supervision of the mining and concentrating of the carnotite, and the National Radium Institute agreed to furnish the necessary funds for mining and concentrating a sufficient supply of ore and for recovering from it the radium, uranium and vanadium. Under this agreement a radium-recovery plant was built in Denver, Colo. The plant began commercial operation in June, 1914, and when it stopped work in January, 1917, about 8½ grams of radium had been extracted. The cost of recovery under the methods devised by the Bureau of Mines was only about one-third the current price for radium. In addition, methods of saving the uranium and vanadium in the ores and of obtaining the metals in a pure state were perfected.

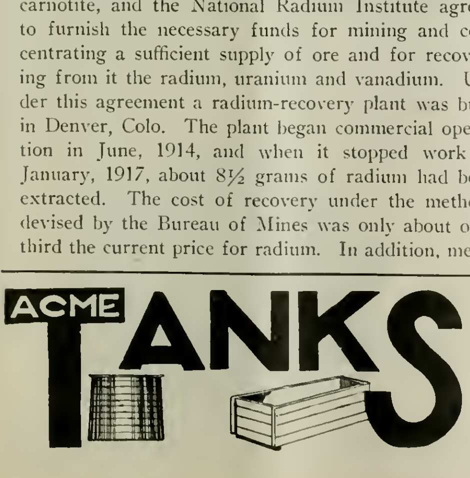
"The agreement between the National Radium Institute and the Bureau of Mines expired in 1916. As a result of the work under this agreement, the Bureau of Mines has been able not only to demonstrate that radium can be produced at a cost much less than the selling price, but it also has been able to show how losses in mining and concentrating carnotite can be prevented and our resources of this wonderful element conserved. Finally, for an expenditure of less than $38,000, the bureau has received as its share of the results of the co-operative agreement more than $180,000 worth of radium.

"The work of the Denver plant was discussed in Bureau of Mines Bulletin 104, 'Extraction and Recovery of Radium, Uranium and Vanadium from Carnotite.' In the present bulletin, K. L. Kithil, mineral technologist, and J. A. Davis, assistant mining engineer, describe the methods used in mining and concentrating the carnotite treated at Denver. As the workable carnotite deposits of Colorado and Utah, though lying near the surface, are relatively small, very greatly in richness, and are extremely irregular in distribution, methods such as are ordinarily used for prospecting and mining shallow deposits have to be modified. Also, it is necessary to examine the ore carefully, sort it closely, and frequently test its radium content with the electroscope. Finally, the carnotite deposits are mostly in an arid region, where water for any purpose is scarce, so that dry rather than wet methods of concentration must be used at most places. Hence the authors have given detailed information in regard to many operations that might receive little notice in an account of the mining of most metals, but

(Concluded on page 319.)

The Reed Laboratories
RESEARCH AND ANALYTICAL
SPECIALIZING IN LEATHER
TANNING AND DYEING MATERIAL
227 Fulton Street, New York, N. Y.

C. L. PARKER
Chemical Patents
TRADE-MARKS
UNFAIR COMPETITION
McGill Building, Washington, D. C.



ANY SIZE OR SPECIFICATION

Three factories, situated in the East, Middle West and Pacific Coast, enable us to give you special service in the manufacture of tanks.

We have on hand reserve supplies of air-dried woods suited for the different chemical requirements, making prompt shipments possible.

Our many years' experience in handling tanks to standard and special specifications should be of value to you. Your specifications will have our immediate and careful attention.

ACME TANK COMPANY
37 Cortland Street, New York

WAR WHO

SAVINGS SAVES

STAMPS SERVES

WAR SAVINGS STAMPS DELIVERED TO YOUR HOME

Tear Out—Fill In—Hand Letter-Carrier—or Mail to Post Office

TO THE LOCAL POSTMASTER:—Kindly have letter-carrier deliver to me on ____________ (Date) for which I will pay on delivery:

________ (State number wanted) $5. U. S. WAR-SAVINGS STAMPS at $______ (See prices below) each

________ (State number wanted) 25c. U. S. THRIFT STAMPS at 25c. each.

Name ________________

Address ________________

W.S.S.
WAR SAVINGS STAMPS
ISSUED BY THE
UNITED STATES
GOVERNMENT

W. S. S. COST DURING 1918

April	$4.15	July	$4.18	Oct.	$4.21
May	4.16	Aug.	4.19	Nov.	4.22
June	4.17	Sept.	4.20	Dec.	4 23

W. S. S. WORTH $5.00 JANUARY 1, 1923

NEW PUBLICATIONS

(Continued)

the presentation of these facts in regard to carnotite is necessary because of their bearing on profitable mining and concentration, the utilization of low-grade ore, and the prevention of waste."

The "American Fertilizer Handbook" for 1918 Now Ready

The happenings of the past year have been of unusual importance and value to everyone interested in the fertilizer industry and its allied trades. By virtue of their character, fertilizers play an important part in food conservation, and for that reason the Government has been operating directly with the members of the trade, through the Committee on Fertilizers of the Chemical Alliance.

The secretary of this committee is Mr. John D. Toll, who is also editor of the "American Fertilizer Handbook," just issued from the press of Ware Brothers Company, Philadelphia, 1918. Because of the fact that Mr. Toll spends fully one-half of his time in Washington for the express purpose of keeping in close and constant touch with the Government on this subject and to assist the committee in its work, he has, therefore, in compiling the 1918 edition of the American Fertilizer Handbook, been able to include all this important information, thereby rendering this work more valuable and complete than ever.

In addition to the usual directories, so useful to the trade, it contains condensed information on all important fertilizer facts which have transpired during the year, all under one cover and handy for ready reference. It constitutes a work which should be in the hands of everyone interested in the advancement of the industry in this country.

First Two Government Picric Acid Plants.

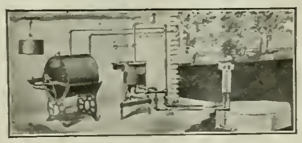
Contracts have been awarded by the Ordnance Dept. U. S. A. for the erection of two large plants for the manufacture of picric acid. The plants will be located at Little Rock, Ark., and at Brunswick, Ga., and will cost $4,000,000 and $7,000,000 respectively. The Everly M. Davis Chemical Corp. will erect the Little Rock plant, while the Butterworth-Judson Corp., of New York City, will erect the works at Brunswick. These will be the first government controlled picric plants to be established in this country.

Du Pont Enlarging Haskell Plant.

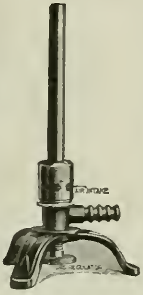
Construction work has been begun on an addition to the E. I. DuPont de Nemours Co.'s plant at Haskell, N. J. The addition is one-story, 20x40 feet.

O'Brien Synthetic Dye Co.

The O'Brien Synthetic Dye Co. has been incorporated with a capital of $50,000 at South Bend, Ind., to manufacture dyestuffs, chemicals, etc. The incorporators are Jerome J. Crowley, George L. O'Brien, Will G. Crabill, S. J. Crumpacker and Ray Heylman, South Bend, Ind.



Gas for—
laboratory and industrial uses
—automatically made
by the
Detroit Combination Gas Machine
Descriptive catalogue and names of users in your vicinity sent on request.
Detroit Heating & Lighting Co.
616 Wight Street, Detroit, Mich.
Established 1868



"Detroit"
Laboratory Burner

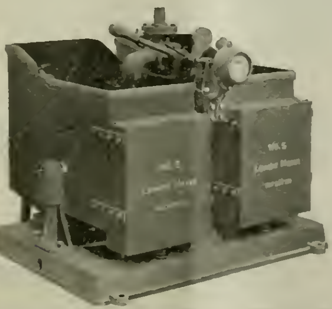
McCormack & Company
Chemists and Chemical ENGINEERS

Analytical and Consulting Chemists

We enjoy making the unusual chemical analyses such as most chemists do not like to bother with.

We have at our disposal the best equipped laboratories in this country for the study of chemical manufacturing processes and problems.

OFFICE and LABORATORIES
33rd and Armour Avenue
CHICAGO Phone Douglas 390



"MORE THAN A METER"

The Improved Leinert Automatic Liquid Gravity Scales

(PATENTED)

A Simple-Positive Mechanical Balance for Recording by Weight. Recommended for WATER—JUICES—BRINE—CAUSTIC SOLUTIONS and LIQUIDS of all descriptions.

Not Affected by Temperature Changes or Variations in Specific Gravity. Special Scales to Meet Your Requirements. WRITE US YOUR SERVICE CONDITIONS.

JOHN SIMMONS COMPANY
107-111 Centre Street :: New York City

H. A. METZ & CO., Inc.

122 HUDSON STREET, NEW YORK

BOSTON PROVIDENCE PHILADELPHIA CHICAGO SAN FRANCISCO CHARLOTTE ATLANTA

PRODUCTS:

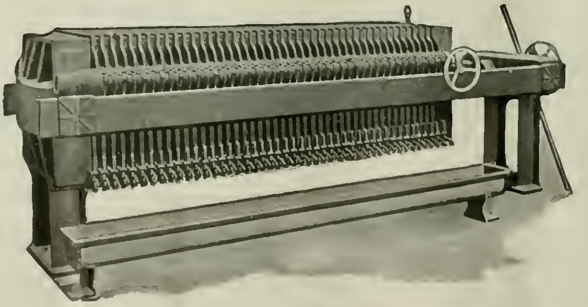
Dyestuffs, Colors, Intermediates, Sizing and Finishing Materials

Dyestuffs, Colors, Sizing and Finishing Materials } *Produced by* { Consolidated Color and Chemical Co. Newark, N. J.

Dyestuffs and Intermediates } *Produced by* { Central Dyestuff and Chemical Co. Newark, N. J.

Shriver Filter Presses

FOR ALL PURPOSES



SIDE FEED FILTER PRESS

FILTER PRESS PUMPS FILTER CLOTH AND PAPER

SEND FOR CATALOG "B"

T. SHRIVER & COMPANY

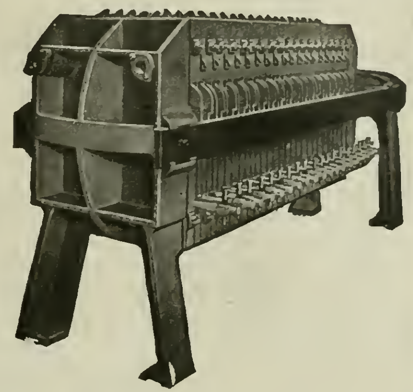
Office and Works: 812 Hamilton Street HARRISON, NEW JERSEY

The "Johnson" Diaphragm Pump

15,000 "Johnson" Filter Presses

NOW IN USE

All Types, All Sizes
Made of
Iron, Bronze, Lead, Aluminum,
Tin and Wood,
also
Belt, Steam and Electrically
Driven
Filter Press Pumps
and
Turbine Mixers



Backed by Forty Years' Experience

John Johnson Company
37th Street and Second Avenue, Brooklyn, N. Y.

Our New Factory for the Manufacture of Pure Fused Silica, known as

SiDiO

has just been opened in New York City. A part of the output has already been assigned to the Government, but production is on such a scale as will enable us to meet your needs promptly.

SIDIO Ware is coming into wide use, both because of its low cost compared to platinum and other wares which it replaces, and also because of its technical superiority.

SIDIO withstands rapid temperature changes, it may be exposed to a continuous temperature of 1200° C. SIDIO has a coefficient of expansion one-seventeenth that of glass or platinum.

SIDIO is especially adapted for Combustion and Pyrometer Tubes, Sulphuric and Nitric Acid Condensing and Cooling Apparatus, high temperature gas analyses.

During the National Exposition of Chemical Industries to be held at Grand Central Palace, New York, week of September 13th, 1918, we shall occupy booth 45 on the main floor and display a representative line of our articles.

THE SIDIO COMPANY OF AMERICA, Inc.
37-39 MURRAY STREET, NEW YORK CITY

Largest American Producers of

Dyes for Army and Navy Uniforms

Army Khaki, for Cotton and Wool
Blues, for Navy Cloth

Coal-Tar Intermediates for Explosives

Diphenylamine
Dimethylaniline
Monochlorbenzol
Dinitrophenol
Aniline Oil

National Aniline & Chemical Company
Incorporated

Main Sales Office: 21 Burling Slip, New York

NATIONAL U.S.A. COLORS

BRANCHES:
Boston
Charlotte
Chicago
Cincinnati
Hartford
Kansas City
Milwaukee
Minneapolis
Philadelphia

Back up the Boys in France — Buy W. S. S. regularly

THE CHEMICAL ENGINEER

Copyright, 1918, by McCready Publishing Company

VOL. XXVI. AUGUST, 1918 No. 9

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

LAURANCE T. CLARK,
Editor.
CHARLES B. DAVIS, F. C. S., Consulting Editor
H. C. DAYCH, Business Manager

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, AUGUST, 1918

Tickets for Chemical Exposition

Readers of the Chemical Engineer who can make use of tickets to the Fourth National Exposition of Chemical Industries to be held at the Grand Central Palace, New York City, during the week of September 23, can obtain them by writing to this office. The Chemical Engineer will be glad to accord a hearty welcome, together with whatever services or information it may be within our power to furnish, at Booth 465, which will be located at the extreme rear of the third floor, close to the entrance of the Motion Picture and Conference Hall. (Take elevator.) Our readers are cordially invited to make this booth their headquarters. Let us know your requirements as soon as possible, and your tickets will be forwarded at once, with our compliments.

A Luxury for the Industrial Chemist................ 323
One Way to Help.............................. 324
Thrift Stamp Purchases 325
Equitable Sulphur Distribution........................ 326
Government Seeks to Increase Coke Output............ 326
To Standardize Petroleum Products.................. 326
A Portable Apparatus and Simple Method for Determining SO_2—Adapted for the Use of Engineers in Mine Examination Work.............. 327
G. W. Jones, J. H. Capps and S. H. Katz.
Additional Plans for Fourth National Chemical Show.. 333
New Sources of Fertilizing Elements.................. 334
The Estimation of Potash.......................... 336
Bertram Blount, F. I. C.
The Nomenclature Used in Colloid Chemistry—A Plea for Reform 338
Arthur W. Thomas.
Inorganic Chemical Synonyms: Part VI—Conclusion.. 341
Elton R. Darling.
Ultra Violet Light: Its Application in Chemical Arts. Part XVI 343
Carleton Ellis and A. A. Wells.
Beet Sugar Pulp as Cattle Feed...................... 347
Coal-Tar Chemistry Section.......................... 349
—National Aniline Continues Education of Consumer. 349
—Manufacture of 2-Amino-Anthraquinone.......... 350
—Device for the Sulphonation of Aromatic Hydrocarbons 351
—Manufacture of Chlorobenzene 351

A Luxury for the Industrial Chemist

The old saw which calls attention to the sudden deep and abiding public interest in the dearth of water when once the well chances to run dry, never received a more forcible demonstration throughout the entire course of its long and useful career than it did in this country in the Year of Dis-Grace, 1914, when the Teutonic wells from which we had been merrily drawing our principal supply of synthetic drugs, dyes and other chemicals—with never a thought of the morrow!—all "ran dry" with an abruptness and a unanimity which fairly took our breaths away and left us floundering about in a mad attempt to stave off one of the most serious industrial droughts which ever threatened these United States.

But once the first shock was over and we began to take account of our needs, the chemists of this country set quietly and methodically to work to supply them. At first there were the really vital fundamentals to be seen to; potash and nitrates, and, almost as pressing, important intermediates for the production of synthetic drugs and medicinals, dyestuffs and explosives, were of necessity our chief concern for the time being. We also were in urgent need of many forms of laboratory apparatus to aid us which had likewise constituted one of the principal streams from these self-same German and Austrian wells.

From that time forward our record has been one of steady progress as, step by step, we have systematically conquered one difficulty after another until, at length, we have at least attained a point where our major necessities are pretty well provided for. We are not, of course, as yet in that ideal state where we can sit back in the calm realization that we are sufficient unto ourselves so far as depending upon outside sources is concerned, but at least we know where much of these products is coming from in future, and we know that the continued application of research through the next few years will bring us continually nearer to this goal.

We *are* in a position, then, where we can draw breath and turn part of our attention to some of those less vital and more highly complex products which constitute the luxuries, so to speak, of our industrial chemical life. This fact is amply proved by the news of a project now being undertaken by a firm whose practically unlimited facilities, capital and staff of technical men give every assurance of its being carried out successfully.

Of more than usual interest to the chemical fraternity in general and to users of some of the rarer and more difficultly obtainable organic compounds in particular, comes the announcement from Dr. C. E. Kenneth Mees, of the Eastman Kodak Company, that this concern is about to establish a separate section of its laboratory, to be known as the "Department of Synthetic Chemistry," for the sole purpose of filling in the gaps which at present exist in our supply of these reagents for research and industrial purposes.

In a communication to this journal, Dr. Mees sets forth the details of the project as follows:

"In order to provide for the supply of organic reagents for research and industrial purposes the Eastman Kodak Company has determined to commence their preparation in its research laboratory.

"This decision was arrived at as a result of the articles published by Dr. Roger Adams and of a recent letter by Professor Gortner in "Science" (June 14, 1918, p. 590), which drew our attention to the need for an adequate supply of these materials produced by a firm of standing.

"In order to carry on the work a separate section of the laboratory has been established under the title of the "Department of Synthetic Chemistry," which will be under the immediate direction of Dr. H. T. Clarke, well known for his publications on organic chemistry.

"In order to make available to research laboratories in this country the organic chemicals which they require, it is proposed that chemicals for research work shall be supplied at the lowest possible price. At first, no doubt, this price will necessarily be higher than that charged by the German firms before the war, but it is hoped that eventually the profit made on chemicals supplied for commercial purposes may enable the rarer materials made in small quantities for research work to be sold at a price which will be within the reach of all who require them.

"At first, of course, the laboratory will be able to supply only a limited number of substances, and these in small amounts, but the department will be expanded to meet the demand and with the assistance of other laboratories interested in organic chemistry, and of the firms who are producing dyes and intermediates, it is hoped that after a time an adequate supply of synthetic organic reagents can be made available.

"It is possible that laboratories may have in stock unusual reagents which they are unlikely to require. If any laboratories possessing such reagents will write to us we shall be glad to make an offer for the materials, thus making them available on the market.

"Our thanks are due to many of the chief chemists of the country who have encouraged us to commence this work and especially to Professor Roger Adams for the way in which he has received our proposals and has assisted us by placing at our disposal the information as to this work which he has accumulated.

"Communications regarding reagents should be addressed to the Research Laboratory, Eastman Kodak Company, Rochester, N. Y."

The project is not only thoroughly patriotic, but in addition will fill a long-felt want and should prove of inestimable value to the country at large as time goes on and the new department's repertoire of available reagents grows in volume.

The determination of the firm to essay the dual role of producer and clearing house serves to indicate more strongly an unselfish desire to further the aims of our industrial chemists and research men and in this way to hasten our approaching independence.

The originators of the undertaking are deserving of the highest commendation, and we feel sure that readers of this journal will join us in wishing them every success in its development.

One Way to Help

Through the Editorial Conference of the New York Business Publishers' Association, A. Mitchell Palmer, Alien Property Custodian of New York, has recently issued the following statement regarding the law relating to enemy-owned property in this country which, it is hoped, will indicate clearly to readers of the Chemical Engineer just how they can aid in rounding up additional properties at present unlawfully held. Mr. Palmer's statement follows:

There are two ways of making war against an enemy. One by force of arms; the other by force of economic pressure.

When a nation wages economic war it brings to bear upon the enemy every force it can muster to stop his supply of food, money and munitions and thereby make him weak and impoverished.

The day the United States entered the war there was in this country millions upon millions of dollars belonging to Germans. It was invested in mines, factories, banks, steamships, farms, plantations, etc. Its total amount might run into billions. We had no way of estimating then. But we did know that it was German gold that was colonizing industries here in America and that it was good American money that was being shipped back to Berlin in the form of earnings to enrich the German nation, to fill the war chests, to help complete its great plan for a world control of commerce and industry.

When war was declared the Army and Navy started to mobilize men and guns, the Shipping Board to build the fleet; the War Trade Board to cut all commercial relations with the enemy, and the Alien Property Custodian to gather into the Treasury of the United States every penny of German-owned money that could be found. That is why the office of the Alien Property Custodian was created.

The duties of the Alien Property Custodian are exactly what the name implies, only in addition to the work of taking over and administering holdings of enemies, he has been given power by Congress to sell outright these properties belonging to the great industrial and corporation classes of Germany planted here in America.

In order to help, it is important to know just *who* is an "enemy" and *what* is "enemy" property.

Enemy property includes any and every kind of property, money, chattels, securities, lands, indebtedness, accounts receivable, etc., which belongs to an enemy. Even if the property is held in the name of another—by a dummy or in trust—if the real beneficial interest belongs to an enemy, it is enemy property.

An enemy under the Act is:

1. Any person regardless of citizenship or place of birth who is within the boundaries of Germany, Austria-Hungary, or their allies, or within the territory actually occupied by their military or naval forces. A peaceful and law-abiding German or Austrian citizen residing in the United States is not an enemy; but an American citizen living in enemy territory is an enemy.

2. A person residing outside of the United States and doing business within the territory of enemy countries or their allies.

3. A corporation, if incorporated within the territory of enemies or their allies, or incorporated in any neutral country and doing business within the territory of enemies or their allies.

4. An official or agent of an enemy Government or any subdivision thereof.

5. All natives, citizens, or subjects of Germany or Austria-Hungary interned by the War Department.

6. All citizens or subjects of Germany or Austria-Hungary resident outside of the United States who are (a) wives of officers, officials or agents of Germany or Austria-Hungary, wherever resident; (b) wives of persons within the territory (including that occupied by military and naval forces) of Germany or Austria-Hungary; or (c) wives of persons resident outside the United States and doing business within enemy territory.

7. Citizens or subjects of Germany or Austria-Hungary who are prisoners of war or who have been or shall be interned by any nation associated with the United States in the war.

8. Citizens or subjects of Germany or Austria-Hungary who since April 6, 1917, have disseminated or shall hereafter disseminate propaganda to aid any enemy nation or to injure the cause of the United States, or who have assisted, or who shall assist in plotting against the United States or any nation associated with the United States in the war.

9. Citizens or subjects of Germany or Austria-Hungary who are included or who shall be included in the "Enemy Trading List" published by the War Trade Board.

10. Citizens or subjects of Germany or Austria-Hungary who, at any time since August 4, 1914, have been resident within enemy territory.

Note—Numbers 2, 6, 8, 9 and 10 apply only to persons resident outside of the United States.

Three quarters of a billion dollars worth of property have been reported to the Alien Property Custodian at Washington today, but from our investigation throughout the country we know that there is much more not yet located. Here is where the citizens can render valuable assistance.

You can help the nation by mailing the Bureau of Investigation, Alien Property Custodian, Washington, D. C., reports or information on enemy owned property in your vicinity. You are shareholders in this great combination trust company, department store, and auction sale, now run by the government, and the larger you swell its holdings the more you will back up the Army and Navy now battling against the Hun.

Thrift Stamp Purchases

There Should Be No Let-Up During the Remaining Months.

With the advent of the hot weather a falling off in the sales of Thrift and War Stamps may be expected unless the efforts of the patriotic workers are not suffered to diminish. There need be no falling off in the sales, however, if we all keep our heads and continue to view the situation sanely and clearly. Let each one of us ask himself or herself whether the need for co-operation is as great among the Allies as it was and then, when we have answered our own question in the affirmative (and who could answer it otherwise?) let us make up our minds at once that while the need exists the money shall be supplied. There were a million reasons advanced during the last Liberty Loan campaign why every one should subscribe and induce others to do likewise, and there was not a reason advanced at that time that does not apply with just as much force to the War Savings Stamps now.

Some one may say, "But I've bought stamps until I'm almost broke," and they may really feel that they have a valid reason for not buying more, but people who talk like that have failed to grasp the significance of the situation. Such people do not stop to consider their sacrifices as compared to the sacrifices that are being made daily, hourly by the young men of America who are on the firing line in Europe.

There really should be no need to plead with any one to buy stamps and thus have a part, though a small one, in this the greatest movement in the history of man. Every individual should consider this not alone a duty, but a great privilege. Now, viewing the matter from another angle, divesting the question of all sentiment, patriotism and obligation, let us consider it as a matter of dollars and cents.

And let us remember right at the start that we are not giving, we are receiving. We lend on the best security in the world and in five years the loan is returned with interest. But that is not all. Let us also remember that after peace has been restored and conditions return to normal the purchasing value of the dollar will be greater by far than it is now, so that every dollar saved now will doubtless do the work of two or more in a few years.

There is nothing new in the foregoing, but for the sake of emphasizing the importance of the War Savings Stamp campaign let us continue to keep this important matter before the people.

—*Charles Ross Keen, in New York "Evening Sun."*

Equitable Sulphur Distribution

Resolutions were passed at a recent meeting of the Chemical Alliance pledging the organization's co-operation with the Chemical Division of the War Industries Board in the allocation and distribution of sulphur-bearing materials during the war. There is no shortage of sulphur for the manufacture of sulphuric acid and other chemicals vitally necessary in the manufacture of munitions, it was said, but in order that distribution might be perfected and all munition plants receive their full share of raw materials the Chemical Alliance would share the burden of distribution with the board.

A committee was formed to confer with officials of the Chemical Division in the matter of distribution. It was said that a tremendous increase in the output of sulphuric acid was in prospect because of the demands made by munition plants. The committees will see to it that the acid is not used in non-essential manufactures to the disadvantage of the ammunition output. There are more than 250 acid plants in the United States receiving their supplies from the Gulf Coast region, and a regulation of the supply was considered necessary. Horace Bowker of the American Agricultural Chemical Company, 2 Rector street, presided at the meeting. The Government was represented by Charles A. MacDowell, Chief of the Chemical Division of the War Industries Board.

Government Seeks to Increase Coke Output

Announcement has been made recently in the press that new processes for the production of coke are now being sought by the government, Secretary Redfield having authorized the Bureau of Standards to make experiments with two methods of coking high-volatile coal, the Koppers method used by a plant in St. Paul, Minn., and the Roberts process, in operation at Canal Dover, O., either of which, if proved commercially practicable, would increase greatly the output of by-product coke by permitting the use of coal hitherto considered unsuited for coking. Transportation conditions also would benefit, it is said, through the utilization of coal from almost any field, instead of from the restricted area where coking coal now is produced.

Laboratory tests of the Roberts process virtually are complete, and the Bureau of Standards expects to take over operation of the Canal Dover ovens soon with the consent of the owners, for further experimentation.

To Standardize Petroleum Products

The appointment of a committee, which will act under the U. S. Fuel Administration, to standardize petroleum products, has been authorized by President Wilson. The purpose of the committee will be to fix standards to be used in the purchase of petroleum products by the United States and allied Governments in this country. The standard to be determined will replace the English standard now generally used in the United States and it is expected will be extended gradually to commercial use.

The committee, as authorized by the order, will consist of a chairman appointed by the Fuel Administration and representatives of the War and Navy departments, Shipping Board, Railroad Administration, Bureau of Mines, and Bureau of Standards.

Freeburn Joins Wallace & Tiernan Staff

H. M. Freeburn has resigned as Assistant Engineer of the Pennsylvania State Department of Health to become associated with the Engineering Staff of Wallace & Tiernan Company, Inc., New York City, manufacturers of chlorine control apparatus and sanitary engineering specialties.

Following his graduation from the Sanitary Engineering course of the Pennsylvania State College, Mr. Freeburn was an instructor at the institution and was in charge of experimental sewage work. Subsequent to this, he was associated with the Engineering Branch of the Pennsylvania State Health Department.

Geisenheimer Dissolves

Announcement has been made of the dissolution of the firm of Geisenheimer & Co., owing to the retirement of Theodore Geisenheimer from business. The property and assets formerly belonging to the firm have been acquired by Aniline Dyes & Chemicals, Inc., of which Alfred F. Lichenstein is president and treasurer. The first vice-president of the concern is W. H. Van Winckel, formerly sales manager for the Dow Chemical Co., and the second vice-president is Robert Hilton, vice-president of the Ault & Wiborg Co., Cincinnati, Ohio. Henry A. Datter has been chosen secretary.

The new concern will continue the business of the old firm and will enlarge its selling staff for the continuation of the sole selling agency for the dyestuffs, intermediates and chemicals manufactured by the Ault & Wiborg Co. The principal offices of the new corporation will be at Cedar and Washington streets, New York City, with branch offices at Boston, Philadelphia and Columbus, Ga.

A PORTABLE APPARATUS AND SIMPLE METHOD FOR DETERMINING SO_2

Adapted for the Use of Engineers in Mine Examination Work*

By G. W. JONES, J. H. CAPPS and S. H. KATZ

Introduction.

The engineers of the Bureau of Mines have had need for a method for determining the amount of sulphur dioxide in the air of sulphide mineral mines, especially in case of fires. The requirements were an apparatus of strong, cheap and readily replaceable parts, easily portable, and readily workable by the average engineer. With these ideas in mind the method herein described was developed. No especial originality is claimed for it. Similar processes have been used by others for a long time. However, it is believed that this adaptation can be used to advantage in the particular field for which it was planned. During the experiments observations of the effect on the senses of sulphur dioxide gas in various concentrations were also recorded.

The work described herein forms part of a partially completed study of sulphur dioxide which will be published by the Bureau of Mines.

Apparatus.

The main apparatus, pictured in *Figure* 1, consisted of two 2½ liter aspirating bottles with tubulars joined by a rubber tube, clamped with pinch cock. One bottle was completely filled with acidified water to be described later. This bottle was closed with a two-holed rubber stopper. Through one hole was run a 100 cc. separatory funnel with a stem of 1 mm. bore. The top of the funnel was closed by a one-holed rubber stopper glass capillary tube, rubber tube and pinch cock. Through the other hole of the rubber stopper extended one arm of a three-way cock. This arm was bent into U form, for the purpose of directing the incoming stream of gas against the rubber stopper so as to break it up and prevent contact of gas and water as much as possible. The other bottle was closed with a one-holed rubber stopper holding a guard tube. This was filled with soda lime with one inch of cotton wool on top for a filter. The guard tube was closed by a one-holed rubber stopper glass tube and rubber tube with pinch cock.

This apparatus, together with its accessories, were carried in the case shown in *Plate* 1, designed for portability and accessibility. The accessories consisted of five bottles of reagents, to be described hereafter, a 50 cc. graduated cylinder with divisions 0.2 cc. apart, two long glass tubes, and a rubber bulb handpump with rubber tubing attached. The tubes and pump were for use in securing samples. An extra guard tube containing soda lime was provided for use in some special cases.

The outfit and case complete measured 10½x20½x23 inches and weighed 55 lbs.

Solutions.

Aspirating Liquid—

The liquid used to aspirate the sample into the bottle is the purest drinking water, readily available at the place where analyses are to be made. Since such waters vary in alkalinity and other properties which might affect the results, 10 cc. of the sulphuric acid are added to the 2,600 cc. of water needed. The 10 cc. of starch solution are added to serve as indicator.

Plate 1—Case containing apparatus and chemicals for determining sulphur dioxide.

Starch Solution—

250 cc. of starch solution were provided. This was made by mixing 50 grams of starch to a paste with

---

*Published by permission of the Director of the Bureau of Mines.

cold distilled water, diluting to 50 cc. with distilled water, boiling a few minutes, stirring meanwhile, then diluting to one liter with 500 cc. of distilled water containing 2 grams of potassium iodide, and adding a few drops of chloroform as preservative.

Thiosulphate Solution—

250 cc. were provided. The strength was roughly one-fortieth normal.

Sulphuric Acid—

A bottle containing 250 cc. of chemically pure sulphuric acid, of 1.84 specific gravity, provided.

Distilled Water—

One liter provided. This needs no description.

Iodine Solution—

One liter of iodine solution provided. This was approximately 5/100 normal, accurately standardized with arsenic trioxide. One cc. was roughly equivalent to .02% of SO_2 when used in the apparatus.

Preliminary Operations.

Before taking a sample, a few cc. of the iodine solution are poured into the separatory funnel and shaken to wet the walls. All the water in the aspirating bottles is then titrated to the first distinct blue color. Trial during the preliminary work with this method showed that one to two drops of the solution were sufficient to change the liquid from colorless to blue when the point of change had been reached. The point where the change occurs should be closely observed, and this amount for the actual color change should not be exceeded. In case the end point is overrun, a few drops of the thiosulphate solution may be added till colorless and the iodine titration repeated till the exact end point is found.

When the aspirating solution is titrated to the point of color change, the excess iodine is wasted onto the ground by allowing it to drain from the separatory funnel through the capillary tube for one-half minute.

Taking the Samples.

Two conditions may confront the operator in securing the samples: In the one case the operator is standing in the atmosphere which is to be analyzed. Here the method of sampling is obvious. In the other case, the sample is to be taken from behind a wall or brattice.

In case the sample must be taken from behind a brattice, an opening is first to be provided. The rubber tube attached to the intake end of the handpump is attached to a glass tube and the glass tube pushed through the opening. The end of the tube should extend at least a foot beyond the inside wall. The excess opening in the brattice should then be stopped with moist earth or a handkerchief. The rubber tube on the discharge end of the handpump is slipped over the tube and the cock turned so as to pump into the outside air. The pump should be worked about three minutes, till the gas from behind the brattice fills all the tubes. Then the cock is turned so as to connect with the interior of the bottle.

The sample bottle is held about three feet above the other to allow rapid transference of the water. On trial, about 45 seconds were required for this. The bottom of the bottle should be held level and as much water allowed to flow out in this position as will. Calibration showed 2,500 c.c. plus 10 c.c. to be the volume of gas sucked into the bottle under these conditions.

Determination of Sulfur Dioxide.

When the sample is secured, 50 c.c. of iodine solution, measured in the graduated cylinder, are poured into the separatory funnel and the rubber stopper replaced in the funnel. When handling the iodine solution in an atmosphere containing sulfur dioxide, it must be borne in mind that the atmosphere acts upon the reagent. Hence it should be protected as much as possible and handled rapidly when exposed. The free end of the small rubber tube connecting with the separatory funnel is taken between the teeth of the operator, the pinch cock let down till the tube ran through the circle, pressure is blown upon the iodine solution as desired and the tube pinched shut with the teeth. The titration is now made, during which the pressure on the iodine solution is increased or decreased as needed. During the titration, the bottle is vigorously shaken so as to rinse all parts of the walls with the solution in the bottom. When the endpoint is established, half the displacing liquid is allowed to run back into the titrating bottle. When the surrounding atmosphere contains sulfur dioxide, this should be done rather slowly, the bottles being on the same level and the guard tube being securely in place and its clamp opened. The water in the titrating bottle is then again titrated to the endpoint, after which the rubber stopper holding the separatory funnel is transferred to the other bottle and the other half of the water solution titrated to the exact endpoint. This completes the titration.

The residual iodine solution is run into the graduate, allowed to drain half a minute and the volume read. The difference between this and the original volume is the volume used in titrating.

In case the determination must be made in an atmosphere where breathing apparatus is necessary, the pressure on the iodine solution in the separatory funnel may be made by means of the handpump and retained by means of the pinch cock. In this case the extra guard tube of soda lime should be inserted between the funnel and the pump.

When less than 5 c.c. of the iodine solution are needed to make a titration it has been found best to repeat the experiment with a more dilute iodine solution. The funnel is rinsed with distilled water and drained. 5 c.c. of the iodine solution are measured into the graduate and distilled waste added to the 50 c.c. mark. The solution is thoroughly mixed, poured into the separatory funnel and the experiment repeated. Trial showed that a distinct endpoint could be established in a dark room by the light of a flashlight with five drops or less of this dilute solution.

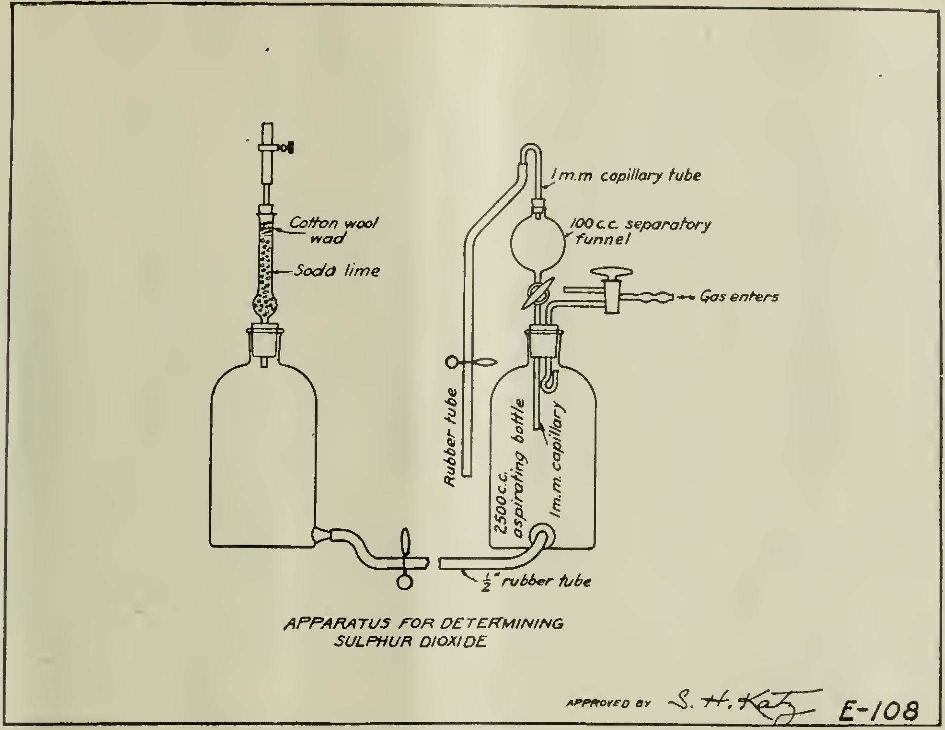


Figure 1—Apparatus for determining sulphur dioxide in air.

Calculation of Percentage of Sulfur Dioxide.

The iodine solution should be standardized to read cubic centimeters of sulfur dioxide at 760 m.m. and 0° C. Changes in barometric pressure and the temperature would affect the determinations, and for that reason must be taken into account in making the calculations. Standard conditions of 760 m.m. barometric pressure and 0° C. temperature should be the basis for comparison of all analyses. *Figure* 3 is a graph of factors to be used to reduce observed percentages to those at the standard conditions. An example will show how these are to be used:

11 c.c. of iodine solution were used to titrate the SO_2 in a sample, the barometer stood at 720 m.m. and the temperature was 15° C., 1 c.c. of the iodine solution was equivalent to .4327 c.c. of sulfur dioxide gas at standard conditions. What was the percentage of sulfur dioxide in the gas when reduced to standard conditions?

$.4327 \times 11 = 4.76$ c.c. SO_2 at standard conditions were in the sample.

$$\frac{4.76}{(2{,}500 = \text{vol. in analyzing bottle})} \times 100 = .1904 \left\{ \begin{array}{l} \text{Apparent per-} \\ \text{centage of } SO_2 \end{array} \right.$$

1.55 is factor for 720 m.m. from graph.

1.055 is factor for 15° C. from graph.

$.1904 \times 1.055 \times 1.055 = .21\%$ SO_2 at standard conditions.

In doing the work, recording data and making calculations it is best to carry through three significant figures. Then cut those beyond the nearest second significant figure when the calculation is completed. When the percentage of sulfur dioxide is below 1%, no accuracy beyond the two figures can be claimed for the method.

It is obvious that the calculations can be shortened when one set of apparatus and solutions are used continuously for analyses, by means of factors common to all calculations.

Tests of the Method.

To determine the efficacy of the method, a room was filled with an atmosphere containing sulfur dioxide by burning sulfur. Two electric fans were operated in it continuously so as to produce uniform composition. At the time that the samples were taken into the apparatus, another sample was taken by the standard vacuum tube method of the Bureau of Mines.* This sample was later analyzed with a Haldane apparatus. With this apparatus, the total gases absorbed by potassium hydroxide were found. From the percentage of total alkali soluble gases .03% was subtracted for the carbon dioxide. The remainder was sulfur dioxide.

Table 1 gives the results of these tests.

---

*Burrell, C. A., and Seibert, F. M.: "The Sampling and Examination of Mine Gases and Natural Gas." Bulletin 42, Bureau of Mines, 1913, 116 pp.

Table 1.

Tests of the Iodine Method for Determining Sulfur Dioxide—1 c.c. Iodine Solution Equaled .4327 c.c. SO_2 at 760 m.m. and 0° C. Determinations were made at 745 m.m. and 15° C.

Test No.	Total Iodine Solution used. c.c.	Residual Iodine Solution after titration of gas. c.c.	Difference = Iodine Solution used in titrating the SO_2. c.c.	Iodine Solution used in titrating the water solution. c.c.	Total Iodine Solution used. c.c.	SO_2 at 760 m.m. and 0° C. %	SO_2 by absorption. %
1	55.0	53.0	2.0	...	2.0	.037	.02
2	50.0	33.0	17.0	2.5†	19.5	.36	.35
3	50.0	36.0	12.9	2.0	14.0	.26	.26
4	50.0	36.5	11.5	2.0	13.5	.25	.25
5	50.0	7.5	42.5	4.0†	46.5	.87	.79
6	50.0	26.5	23.5	3.5	27.0	.50	.42
7	50.0	32.5	17.5	2.5	20.0	.37	.27
8	50.0	36.0	14.0	2.0	16.0	.30	...
9	50.0	40.0	10.0	1.5	11.5	.21	.22
10	50.0	41.0	8.6	1.5	10.0	.19	.15
11	40.0	34.0	6.0	1.0	7.0	.13	.12
12	50.0	38.0	12.0	1.5	13.5	.25	.23
13	35.0	27.0	8.0	1.0	9.0	.17	.16
14	26.0	20.0	6.0	1.0	7.0	.13	.13
15	25.0	20.5	4.5	.5	5.0	.093	.11
16	$\frac{25.0*}{5}$	$\frac{11.0*}{5}$	2.6	.0	2.8	.032	.06
17	$\frac{25.0*}{5}$	$\frac{14.0*}{5}$	2.2	.0	2.2	.041	.05
18	$\frac{25.0*}{5}$	$\frac{16.0*}{5}$	1.8	.0	1.8	.034	...
19	$\frac{25.0*}{5}$	$\frac{18.5*}{5}$	1.3	.0	1.3	.024	...
20	$\frac{25.0*}{5}$	$\frac{20.5*}{5}$	.9	.0	.9	.017	...
21	$\frac{25.0*}{5}$	$\frac{21.5*}{5}$	.7	.0	.7	.013	...
22	$\frac{25.0*}{5}$	$\frac{22.0*}{5}$	.6	.0	.6	.011	...
23	$\frac{25.0*}{5}$	$\frac{23.0}{5}$	.4	.0	.4	.0074	...
24	$\frac{20.0}{5}$	$\frac{18.5}{5}$	.3	.0	.3	.0056	...
25	$\frac{18.5}{5}$	$\frac{17.5}{5}$	.2	.0	.2	.0037	...
26	$\frac{17.5}{5}$	$\frac{16.5}{5}$	.2	.0	.2	.0037	...
27	50.0	34.0	16.0	1.5	17.5	.33	...
28	50.0	41.7	8.3	.0	8.3	.15	.15
29	50.0	45.0	5.0	.5	5.5	.10	.09
30	20.0	17.0	3.0	.0	3.0	.056	.06
31	$\frac{50.0}{5}$	$\frac{40.0}{5}$	2.0	.0	2.0	.037	.04
32	$\frac{40.0}{5}$	$\frac{36.5}{5}$	.7	.0	.7	.013	...

---

*The fraction expressions with 5 in the denominator mean that the Iodine Solution was diluted 1 to 5 with distilled waters. †Figures were interpolated, not determined.

In tests 18 to 26, *Table* 1, the concentration of sulphur dioxide was too low to be determined by the laboratory method. But the changes of concentration, as indicated by the iodine method, with time, were recorded for these tests and the previous ones, beginning with No. 15. These are plotted in *Figure* 2. It is seen that the change with time of the concentration of the sulfur dioxide in the room forms a smooth curve of the kind to be expected.

Other tests of the method throughout its entire range were made by analyzing synthetic mixtures of air and sulfur dioxide of known composition. The results are given in *Table* 2.

The errors of measurement in forming the synthetic mixtures were as large or larger than those from the iodine determination. The results of this table indicate not the absolute accuracy of the method but rather the fact that it may be depended upon to indicate sulfur dioxide in air from a minimum of a few parts per million to a per cent or more.

Table 1 shows the accuracy better. The method is fully as accurate as the most precise gasometric laboratory methods within the range of the laboratory apparatus; furthermore, it has a range extending down to a lower limit of about ten parts per million parts of gas. Though the range extends from this

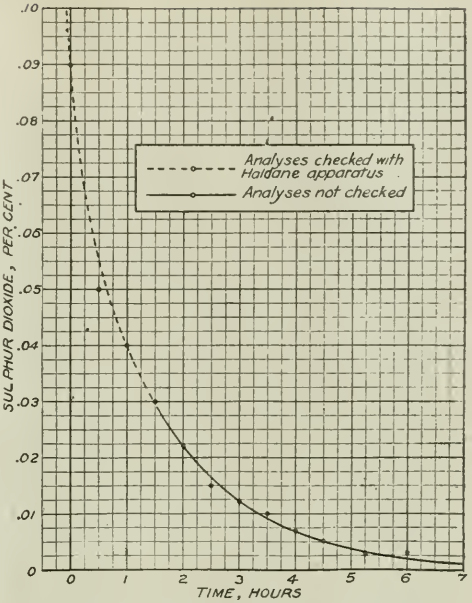


Figure 2—Graph showing change of concentration of sulphur dioxide in air of room, with time.

Table 2.

Results of Analysis of Synthetic Mixtures of Sulfur Dioxide and Air.

SULFUR DIOXIDE.

Test No.	Volume in c.c. 760 mm.-0°		Percentage by Volume.		Parts per Million by Volume.	
	By Measure.	By Titration.	By Measure.	By Titration.	By Measure.	By Titration.
1	.0090	.017	.00048	.00090	4.8	9.0
2	.011	.015	.00058	.00079	5.8	7.9
3	.011	.018	.00058	.00095	5.8	9.5
4	.012	.012	.00063	.00063	6.3	6.3
5	.017	.032	.00090	.0017	9.0	17.
6	.038	.043	.0020	.0023	20.	25.
7	.050	.047	.0026	.0025	26.	25.
8	.067	.091	.0035	.0048	35.	48.
9	.11	.14	.0058	.0074	58.	74.
10	.15	.16	.0079	.0084	79.	84.
11	.19	.18	.010	.0095	100.	95.
12	.34	.36	.018	.019	180.	190.
13	.38	.37	.020	.020	200.	200.
14	.39	.51	.021	.027	210.	270.
15	.76	.71	.040	.037	400.	370.
16	.90	1.1	.048	.058	480.	580.
17	.99	.95	.052	.050	520.	500.
18	2.5	2.5	.121	.132	1210.	1320.
19	4.0	4.3	.211	.227	2110.	2270.
20	10.7	10.6	.565	.500	5650.	5600.
21	15.0	13.5	.792	.713	7920.	7130.
22	15.8	15.0	.834	.792	8340.	7920.
23	17.9	16.8	.945	.887	9540.	8870.
24	18.6	18.0	.962	.951	9820.	9510.

Table 3.

Effects of Sulfur Dioxide in Various Concentrations on the senses.

Concentration of Sulfur Dioxide by Iodine Method. Per cent.	TEST NO.	OBSERVATIONS.
.0037	26	No mask worn. Slight smarting in nose. Slight depression in breathing.
.0037	25	No mask worn. Smarts in nose, slightly depressing to breathe.
.0056	24	No mask worn. Smarting of nose, slightly difficult to breathe.
.0074	23	No mask worn. Smarting of nose, shortness of breath, no discomfort to eyes.
.011	22	No mask worn. Smarted in nose, shortness of breath, produced discomfort of eyes and flow of tears.
.013	21	No mask worn. Smarts eyes and nose. Makes shortness of breath. Could remain in room only with difficulty.
.013	32	Taken without mask, but very difficult. Had to close eyes most of time. Affected the throat and lungs.
.017	20	No mask worn. Smarts in nose and makes the eyes water. Could not remain in room.
.024	19	Without mask could stay in room only short time. Produced choking and shortness of breath.
.034	18	Without the mask the gas badly affected the eyes, nose and lungs. Mask was worn to secure sample.
.037	31	Without mask the gas bites passages in head and throat, breathing is very difficult, eyes smart a bit. Could endure it one-half minute.
.037	1	Smarted in eyes, etc. Mask was necessary to secure samples for analysis.
.041	17	Mask was necessary.
.052	16	Impossible to enter room without mask.
.093	15	Impossible to enter room without mask.
.10	29	———
.13	14	———
.13	11	Hurts small cut on finger.
.15	28	———
.17	13	———
.19	10	Gas penetrated rubber goggles, smarted in eyes.
.21	9	———
.25	12	———
.25	4	Gas penetrated goggles, very blinding on eyes, had difficulty in securing samples.
.26	4	With mask well adjusted work could be done without difficulty.
.30	8	———
.33	27	———
.33	2	———
.37	7	———
.50	6	Mask required very good adjustment to keep out fumes.
.87	5	———

low figure of sulfur dioxide to many thousand parts per million, it may be considered accurate only to two significant figures except in the higher ranges.

Effects of Various Proportions of Sulfur Dioxide in Air on the Senses.

During the experiments in the room containing sulfur dioxide it was necessary to wear breathing apparatus of the type used for mine rescue purposes, in all but the lower concentrations. The apparatus had a mouthpiece for breathing and soft rubber edged goggles which readily conform to and fit the face, for protecting the eyes. The rubber part of the goggles was wet and carefully adjusted to secure accurate fitting. The utmost care was necessary to have perfect adjustment, especially in the higher concentrations of sulfur dioxide. If such care was not taken the gas penetrated to the eyes, producing pain and blindness, which made it entirely impossible to work.

The observations which were made during the tests are arranged in order of increasing concentration of sulfur dioxide in *Table* 3.

By referring to this table an estimate of the proportion of sulfur dioxide in air may be made by an observer without the use of analysis. And estimates may even be made for concentration lower than those investigated. The lowest concentration of sulfur dioxide tested by analysis was about 40 parts per million. At this concentration the air had a biting effect on the mucus of the nose. Undoubtedly at one-tenth of this concentration or four parts per million sulfur dioxide would have a distinct odor.

Other Uses for the Apparatus

Although experiments were not made with other gases which may be determined by means of iodimetry,

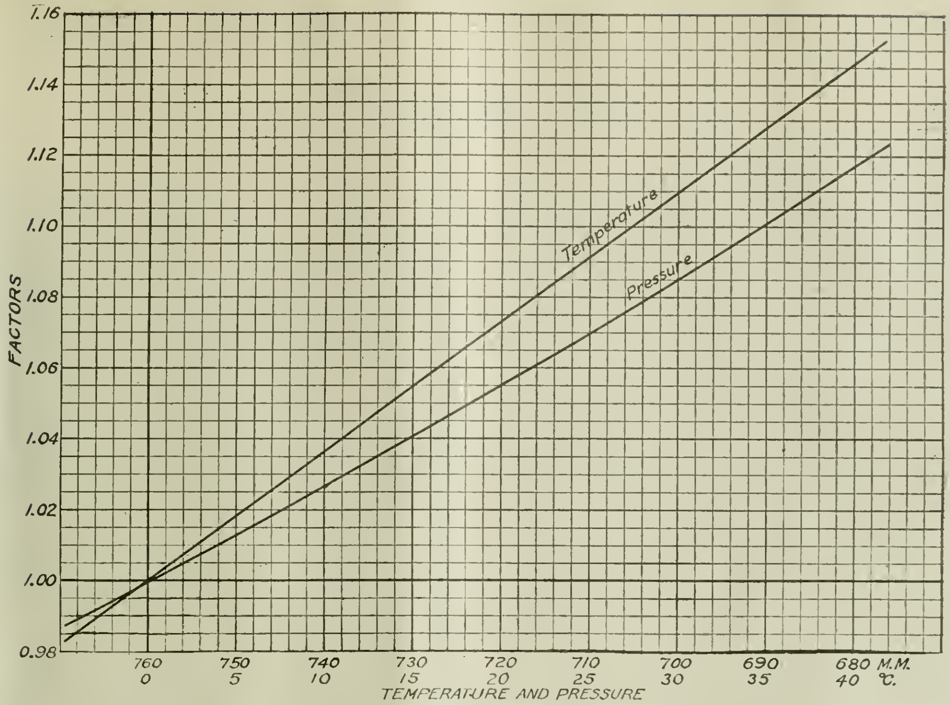


Figure 3—Curves of factors for reducing observed percentages of sulphur dioxide to those at standard conditions.

the apparatus may be used to determine such gases as hydrogen sulphide, chlorine, oxides of nitrogen and some others as well as sulfur dioxide. In the case of the latter two, iodine would be liberated in the water solution which should contain some potassium iodide. The starch-iodine blue solution would then be titrated to colorless by means of a standard sodium thiosulfate solution.

Summary.

A method and apparatus for determination of sulfur dioxide by means of the iodine titration has been developed for the use of engineers working in the field. The apparatus is strong, cheap, easily replaceable and assembled into a case designed for portability. The method is not accurate beyond two significant figures, but has a range from about ten parts per million by volume to one per cent. or more.

Observations of the effect of sulfur dioxide on the senses have been made and arranged in tabular form. With this it is possible to roughly estimate the small proportions of sulfur dioxide without analysis.

To Manufacture Chemicals.

To engage in the manufacture of chemicals and allied products the Allen Mfg. Co. has been incorporated with a capital of $10,000 at Quakertown, N. J., by Harry W. Haver, Walter A. Allen, Harry M. Oakes and George E. Rose.

Additional Plans for Fourth National Chemical Show

In its latest bulletin, the management of the Chemical Exposition has announced for the benefit of exhibitors and others interested that the rumored Government plans for taking over the Grand Central Palace for war purposes will in no wise affect the holding of this event according to schedule.

Present indications are that the Fourth National Exposition of Chemical Industries, to be held in Grand Central Palace, New York, September 23 to 28, will be the greatest exhibition of its kind ever held. Preparations for this gigantic exhibition are well under way and the advisory committee is working hard to make every department of the affair a success.

Some sections of the South again are sending exhibits, and Canada is taking the opportunity of presenting the materials it has available for development by the chemist and financier. Technical and business men over the country should give heed to these exhibits, since they will show how they can meet the war-time need. A section for the glass and ceramic industry has been added with which the American Ceramic Society is co-operating.

Men prominent in the chemical and allied industries will speak on subjects vital to present condi-

(*Continued on page 348*)

NEW SOURCES OF FERTILIZING ELEMENTS

Something of the romance atached to the recent feverish search for new fertilizing materials which followed the shutting off of our supply of potash from the mines of Stassfurt in 1914, is told by William H. Ross, of the U. S. Department of Agriculture, who indicates in his recital, the splendid ability of our industrial chemists when suddenly called upon to cope with the difficult situation.

In describing his search for new sources of fertilizing elements, Mr. Ross points to a striking illustration of the change in value which a product may undergo in the utilization of certain woods, as the oak and the hemlock. In the early development of the country the barks of these trees was the only source of tannin for the manufacture of leather. In many places the collection of bark brought profits that greatly exceeded those obtained from the remainder of the tree, which was allowed to decay or destroyed in clearing the land.

At present the demand for wood products is much greater than the supply. All tops of trees, slabs, edgings, and the sawdust in particular are used for different purposes, as when destructively distilled for the preparation of many chemical products, as alcohol, sugar, and oxalic acid. The residue in this case, as well as when the wood is used for fuel, becomes directly available for use as potash fertilizer, of which the hardwood wastes of the country produces about 19,000 tons annually. The importance of this supply has been greatly emphasized since the war has cut off the principal source of this greatly needed material.

An industry that thrives more than any other on the utilization of waste is the preparation of meat products. Pork, beef and mutton represent only from 40 to 85 per cent. of the animal on the hoof. Time was when a large part of the remaining 15 to 60 per cent was thrown away. At present practically all the profits of this industry are derived from their successful exploitation.

The by-products obtained in the packing house industry may be divided into two classes—the edible and the inedible. The inedible constitute the external covering (hair, horns, hoofs and hides), some of the offal, and the bones. From these are prepared a great variety of substances, some of which have developed into enormous industries in themselves, such as leather, soap, glue and fertilizer. The last mentioned represents the ultimate utilization of packing house waste. For example, in the manufacture of buttons, combs, knife handles and spatulas from the horns and hoofs of cattle and sheep and the hoofs of hogs, the waste resulting from the preparation of these articles was at one time thrown away, but it has been found that by treating such material with sulphuric acid the nitrogen which it contains becomes available as a fertilizer.

Under the trade name of processed fertilizer this waste from a waste is thus profitably disposed of. The trimmings and waste in the manufacture of hair and leather goods are likewise consumed as fertilizer.

Of more importance to fertilizer manufacture is the utilization of the bones, blood, entrails, etc. Incongruous as it may seem, each of these materials is now used in the preparation of a great many different products. Thus the bones may be steamed, ground, and placed on the market under the name of bone meal, or treated with sulphuric acid to make them even more readily available for plant food.

The blood, entrails and other miscellaneous material all find ultimate disposal in what is known as tankage in the fertilizer trade, so valuable for their nitrogen and phosphoric acid content.

The oldest industry to make use of waste for fertilizing is the fish industry. The custom of fertilizing crops with fish existed among the Indians of New England before the arrival of white settlers. It is said that for fertilizing corn one or two fish were buried in each hill. This procedure was adopted by the colonists, and at the time of a large catch the surplus fish were simply spread broadcast over the fields. In places where fish were plentiful this disposal of an over-supply of fish has been practiced until very recent times.

It was soon observed, however, that the response first noted on liberally fertilizing with fish decreased, and the initial good effects could be obtained again only after the soil had been allowed to stand for a time without further applications of fish. This was finally shown to be due to the action on plants of the oil in the fish. When the oil was removed by cooking and pressing the residue no longer caused ill effects and its value as a fertilizer was greatly improved. At present crude fish oil is normally quoted as about 25 cents per gallon, which more than covers the cost of extraction. It thus happens that in the utilization of fish waste the recovery of the extracted residue, or fish scrap, as it is known in the trade, often becomes subordinate to the recovery of the oil.

The principal sources of fish oil and scrap are nonedibile fish, as the menhaden, and the refuse collected in canning factories from the heads, tails, bones, shells, intestines, etc., of edible fish. Non-edible fish furnish the largest supply. The average annual catch of menhaden for the last eight years was about 500,000,000 fish, which, with the refuse collected in canneries, produced about 60,000 tons of scrap and 85,000 barrels of oil. The largest recorded catch was in 1903, when about 1,000,000,000 fish were caught.

Generally speaking, fish scrap contains about 8 per cent. each of nitrogen and phosphoric acid. The presence in fish scrap of a comparatively high percentage of two of the essential plant foods makes it one of the most valuable of the organic fertilizers.

America's largest manufacturing industry is iron and steel. The pig iron recovered in smelting iron ore amounts to about 25 per cent. of the raw materials. The equivalent of about 14 per cent. is driven off by volatilization in the cooking of the coal; in the process of smelting a further 40 per cent. escapes in gas, fume and dust; and the remaining 21 per cent. represents the slag.

In the early history of the industry little was done to utilize any of these wastes. In fact, until the last decade the most that was done was to utilize to some extent the heat from the furnace. Recently, however, much attention has been given to the utilization of waste, and more advance has been made in the efficient operation of the blast furnace than, perhaps, in any other industry.

In 1909 84 per cent. of the coke in the country was prepared in beehive ovens and the remaining 16 per cent. in by-product ovens. In 1916 the output of by-product coke increased to 38.6 per cent. of the total, with every prospect of a still further increase. In the by-product oven there is recovered not only the nitrogen in the coal but a great number of other by-products, which find very extensive application in the manufacture of dyes, explosives, drugs and other products. In this process the nitrogen is recovered as ammonia. By combining this with sulphuric acid ammonia sulphate is formed, which is one of the most important sources of nitrogenous fertilizers. The output in 1915 amounted to 249,000 tons, and in 1916, to 325,000, valued at about $25,000,000.

The economic uses of blast-furnace slag have also been greatly developed the last few years. Formerly this was an incumbrance and its disposal was often a matter of considerable expense. Of much more value as fertilizer is the slag obtained in the preparation of steel from high phosphorus pig iron. To remove the excess of phosphorus the iron is melted in converters lined with limestone, and quicklime is added. At a certain stage air is driven through the molten material, which leads to an accumulation in the slag of the phosphorus originally present in the metal. This slag is drawn off and cooled, and when finely ground is placed on the market under the trade name of basic slag. The phosphoric acid in the slag prepared in this way varies from 11 to 23 per cent.

For a long time the fertilizing value of the slag was not recognized, but it has now become one of the most popular of commercial fertilizers. In fact, on account of its freedom from acidity many prefer it to any other phosphatic material. The slag produced for the fertilizer trade amounts to about 2,000,000 tons annually.

The third main avenue for escape of waste in the blast furnace is volatilization. These losses in the form of gas, dust and fume are receiving special attention at present. In the operation of the modern blast furnace a portion of the waste gases is utilized directly in gas engines for making a blast or for generating electric power, while the remainder is used in burning under boilers and in heating stoves for preheating the blast. The dust collected in the stoves and boilers has long been known to have some fertilizing value, but little attention was given to it until recently, when it was found that the dust collected in some plants contains sometimes upward of 20 per cent. of soluble potash, of great value for use in fertilizers.

In an investigation recently made at one of the steel plants of this country it has been found that the potash in the dust collected in the stoves and boilers amounts to only about 5 per cent. of the total escaping from the furnace. The greater part is still lost in the washers or escapes from the flues. Tests also were made at the same plant with an electrostatic or hot dry process for purifying the gas. The results showed not only potash but other materials, as iron and zinc compounds, which may be carried over in the dust. The possibilities of potash recovery in the steel industry are promising, but, owing to the abnormal condition now prevailing, new developments are likely to be postponed for the present.

A good illustration of a case in which a valuable product is lost in an industry without it being known for a long time that a waste is actually taking place is furnished by the escape of potash from cement plants. In the manufacture of Portland cement an intimate mixture of a material like clay and limestone is heated to the point of fusion. For many years it was thought that in the manufacture of cement this product was the only one produced, and that, therefore, no loss of any other material took place. It is now known, however, that in the burning of cement the potash in the raw materials escapes from the kilns with the flue dust. Even after it was noticed that some loss of potash took place in this way, little importance was attached to the observation until analyses were made four or five years ago of dust collected at the plant of the Riverside Portland Cement Company.

The original object of collecting the dust was to comply with injunction proceedings instituted by orange growers against the escape of dust from the plant. To the surprise of every one the dust when collected was found to contain such a percentage of potash as to make its recovery a profitable procedure entirely apart from any other consideration. Since then a number of additional plants have also installed equipment for collecting potash, and at several other plants installations are now building.

The recovery of potash at the Riverside plant now

(*Concluded on page 340*)

The Estimation of Potash

By BERTRAM BLOUNT, F. I. C.*

Potash is now a material of national interest, and its estimation with accuracy is the root of the whole matter. Such things as felspar, blast-furnace flue dust, the dust from cement kilns were commonly disregarded as potential sources of potash, but the stern necessities of war have taught us to be no longer dependent on the Stassfurt deposits. Usually analyses of silicate rocks, clays, cements, and the like have hitherto ended with "alkalis and loss" or "perte et divers," both phrases quite sufficient for the purpose in view. And here I may remark that of the many thousands of analyses of such materials published by German chemists there is hardly one which does not say "alkalis so much per cent"—which, of course, is impossible unless the mixed oxides are isolated and weighed as such. If weighed jointly as sulphate, as is often done, no such return is possible, and if they are computed by estimating the sulphuric anhydride, then they should be stated separately.

With soluble materials containing potash there is little difficulty save in the later stages of the process, but in the case of the substances cited above some complications may arise.

Substances containing potash in a soluble form can be leached out and the potash estimated in the usual way. What potash can be regarded as soluble has to be decided by an arbitrary method; it is generally agreed that the citric acid process is suitable. But, as in the case of basic slag, the material may be available, although not immediately soluble.

Therefore it comes to this: That the whole of the potash in whatever form in any substance shall be estimated. Such a method is on a par with the absolute method of Dumas for nitrogen. All that is needed is the potash—as in the Dumas case, the nitrogen.

Taking, then, a general basis, it may be said that the sound principle of eliminating everything from the substance analysed, except the substance to be determined, must be adopted. Everything must be cleared out. Shortcuts, useful for particular purposes, are practically useless in this case. Blank tests must be made throughout, and analyses of mixtures containing a known amount of potash are desirable. The method used in my laboratory is as follows:

Method of the Estimation of Potash in Siliceous Rocks, Clays, etc.

Opening Up.—It is essential that the whole of the material should be in solution, and for this purpose many different methods have been suggested, such as that by Lawrence Smith. In practice, however, I have found that treatment by hydrofluoric acid, together with sulphuric acid, is by far the most accurate and satisfactory method.

The method which I have adopted is as follows: A small portion of the bulk ground sample is very finely ground in an agate mortar, and if necessary dried again. One-half a grm. to 2 grms. is weighed out and transferred to a fair-sized platinum crucible, and digested for two or three hours with 10 cc. purest hydrofluoric acid (that supplied in cerasin bottle) and 2 cc. sulphuric acid (*puriss.*). If necessary, a further 10 cc. of hydrofluoric acid is added, and the whole gently evaporated till most of the sulphuric acid has been fumed off, great care being taken to prevent loss by "spurting." The anhydrous sulphates are taken up by digesting with hydrochloric acid, and the diluted solution filtered off through a small filter, retaining the insoluble matter in the dish. This is further digested with hydrochloric acid and filtered off as before, and if any residue still remains, which is usually due to insufficient attack, it is washed on to the filter-paper, which is then thoroughly washed, dried, very gently ignited in a platinum crucible, and the above process of treatment with hydrofluoric acid, etc., repeated. The original grinding in the agate should be so thorough that further grinding at this stage should be unnecessary, as it would involve loss. In the case of materials such as limestone, etc., the bulk of which can be readily dissolved, the method is modified, in that the material is first digested with hydrochloric acid, and the insoluble portion is then treated as above and aided to the main solution.

Removing Other Constituents.—The iron, alumina, and manganese are removed by the addition of bromine and ammonia and a short digestion. The precipitate is filtered off and thoroughly washed. Ammonia is added to the filtrate and the whole boiled. Ammonium oxalate is then added and the whole boiled up again. After the precipitate has been allowed to settle, the calcium oxalate is filtered off and washed thoroughly, and the filtrate gently evaporated to a low bulk. The basin is then covered and sufficient nitric acid is added to destroy the ammonium salts, and, whilst still covered, the whole is evaporated till just dry, or till fumes of sulphuric acid appear. After cooling, the residue is taken up in 2 or 3 cc. of hydrochloric acid and a little water, and gently evaporated to low bulk. The solution is diluted, a small excess of a clear solution of barium hydrate is added, and the whole digested for about half-an-hour, during which time a slight skin of barium carbonate should form on top,

---

*From the *Chemical News*.

showing that an excess is present. The precipitate is filtered off and thoroughly washed, and the filtrate digested with excess of ammonium carbonate, and the precipitated barium carbonate filtered off and washed. The filtrate is evaporated to low bulk on a water-bath, a few cc. of hydrochloric acid are cautiously added, and the whole transferred to a small platinum dish and evaporated to dryness on a water-bath. The residue is very gently ignited over an argand burner to drive off all the ammonium chloride, the crude alkali chlorides dissolved in a small quantity of water, a drop or two of ammonium carbonate added, and digested for a minute or two, and the whole filtered off through a very small filter with thorough washing into a weighed platinum dish. The filtrate is evaporated on a water-bath and the residue carefully ignited over an argand, cooled in a desiccator, and weighed. This is the weight of the pure alkali chlorides.

As potash adheres very persistently to all the precipitates and filter-papers, it is absolutely essential that the washings should be very thorough at all the various stages. It is better to have to remove traces of any slightly soluble precipitate such as magnesia from the crude alkali chlorides than to run the risk of leaving some of the potash in the precipitates or filter-papers.

Separation of Potassium from Sodium.—Although many methods have been tried, such as the cobaltinitrite and perchlorate methods, the older method of platinic chloride still seems the best where accuracy is required. The pure alkali chlorides, obtained as above, are dissolved in a small quantity of water (and should, of course, leave no residue) and sufficient platinic chloride added to combine with the whole of the potassium and sodium salts and leave a slight excess. The solution is evaporated on the water-bath till it begins to get pasty, then cooled, diluted with a sufficient quantity of 80 per cent. alcohol by volume to take up the whole of the sodium salt, and allowed to stand for a few hours. If the quantity of alkali is large, it is better to take up the pasty chlorides in a small measured quantity of hot water, cool, and add sufficient absolute alcohol to bring the final solution to 80 per cent. by volume.

The precipitate of potassium platinic chloride is filtered off, washed with 80 per cent. alcohol till quite free from sodium salts, warmed to drive off the alcohol, and then dissolved through into a weighed platinum dish by means of boiling water, evaporated to dryness, dried in an air-oven, cooled, and weighed.

Platinum Residues.—Many methods have been published, reference to some of which is given below.

The best and shortest way is to take the whole mass to dryness and ignite to full redness (1100° C.). The mass is ground finely and extracted with water, then with hydrochloric acid, washed well, and then extracted with nitric acid. The residue is again ignited and extracted with aqua regia. The solution is evaporated to dryness and taken up with HCl and water.

All solutions except the first aqueous extract are returned to be worked up with the next batch.

References.—Mello, "Treatise on Chemical Analysis," p. 240. Crookes, "Select Methods in Chemical Analysis," p. 462. *Journal of Society of Chemical Industry,* 1897, p. 642; 1901, p. 1902. And many of the ordinary text books.

Addendum.—On account of the scarcity of platinum it is advisable to have an alternative method. The best of these is the perchlorate process, and a good account is given by Mellor in "A Treatise on Quantitative Inorganic Analysis," p. 237, which is here transcribed.

The Process.—"Dissolve the mixed chlorides (see Note) in from 10 to 15 cc. of hot water, and then add two or three times as much perchloric acid as is theoretically required to precipitate the mixed perchlorates. Evaporate the mixture on a water-bath to a syrupy liquid until the fumes of perchloric begin to appear; cool a little. Take up the mass with hot water, and add 5 to 6 cc. of perchloric acid. Re-evaporate until the fumes of perchloric acid again begin to appear. The object of this treatment is to remove the hydrochloric acid. This is important. Stir the cold mass with about 20 cc. of 96 to 97 per cent. alcohol containing 0.2 per cent. by weight of perchloric acid. Keep the potassium perchlorate as coarsely granular as possible. Let settle. Decant through a dried and weighed Gooch's crucible. Wash the residue by decantation through the Gooch's crucible three times. About 20 cc. of the alcohol will be needed for the washing. Transfer the precipitate to the Gooch's crucible by means of alcohol. Some prefer to wash the residue at this stage with 20 cc. of a mixture of equal parts of 97 per cent. alcohol and ether. Dry the precipitate at 120—130° for about half-an-hour, and then weigh as $KClO_4$."

(Note.—The amount is calculated as follows: Assume that the mixed chlorides are all sodium chloride, and that the perchloric acid used is 30 per cent. (sp. gr. 1.20) solution). Multiply the weight of the mixed chlorides by 6, and the product represents the number of cc. of acid required for the work. Perchloric acid of approximately 60 per cent. strength has a sp. gr. of 1.54; 30 per cent., 1.20; and 20 per cent., 1.12. There is no difficulty about keeping the acid. It is not decomposed by hydrochloric or by sulphurous acid. The acid slowly volatilises at 138° C. without decomposition. It is not affected by exposure to light. The strength of the acid is easily determined by titration of a known amount with standard sodium hydroxide with phenolphthaleïn as indicator.)

The process given in the main paper is followed strictly until the mixed chlorides are isolated in a pure state. They are then separated by the perchlorate method instead of by the use of platinic chloride. In other respects the operations are identical.

The Nomenclature Used in Colloid Chemistry—A Plea for Reform

By ARTHUR W. THOMAS[*]

Colloid chemistry is no longer considered as a mere collection of mysterious substances and "abnormal" reactions. It is an important branch of chemical and physical science possessing a fairly well established working basis and is rapidly acquiring new students.

It suffers, however, like all virgin sciences, the affliction of superfluity of terms used to describe essentially the same things, careless and loose use of some expressions, and confusion of nomenclature in general. This condition results in a great handicap to new students. It is very difficult for them to acquire clear conceptions from their first readings of the various works on the subject.

It is time that this matter be taken in hand by some committee of our Chemical Society for the purpose of removing this needless handicap and confusion by defining the various terms used in colloid science, eliminating unnecessary ones and by standardization of the terminology in general, just as was done with the terminology of the proteins by the biological chemists some years ago.

The paragraphs which follow attempt to point out some of the cases of malusage of terms.

Colloidal Solution Defined.

No objection can be raised against the word "colloid." It is distinctive, but the use of the expression "colloidal *solution*" is to be strongly condemned, since it is so evident that substances in the colloidal condition are not dissolved, in the strict sense of the term. Colloidal particles are in a condition midway between solution and mechanical suspension, and they are held in this peculiar state of *dispersion* by virtue of their surface energy, electrical charge, their kinetic energy as manifested by the Brownian movement, and the adsorbed ions of electrolytes which are essential to the stability of all colloids.

The general term "dispersion," as suggested by Wo. Ostwald, is to be preferred to the special term "solution," *e. g.*,

"Mechanical suspensions" are coarse dispersions.
"Colloidal solutions" are colloidal dispersions, and
"True solutions" are molecular dispersions.

The particles, or "internal phase" of these systems are known as the "dispersed phase," and the liquid in which they are dispersed, the external phase, is known as the "dispersion medium."

The present usage of the word "sol' and of its modifications—"hydrosol," "alcosol," etc., to describe a colloidal dispersion, is the same as that of Graham, their originator. I have noticed, however, that the word "sol" has been used by a few writers in the sense of the dispersed phase, *i. e.,* the particles in colloidal dispersion. Is this use of the term to be permitted? Graham invented it as a short and convenient substitute for colloidal "solution" and a perusal of the works by Bechhold, Cassuto, Freundlich, Hatchek, Ostwald, Taylor and Zsigmondy shows that the original sense of the expression has been retained by these writers.

Use of the Term "Gel."

The use of the term "gel," however, and of its modifications, "hydrogel," "alcogel," etc., is deplorably loose and confusing. This term was coined by Graham[1] and first used by him in discussing the "pectization" or coagulation of the hydrosol of silicic acid. Therefore, if we are to limit the use of "gel' to its original sense, we should use it only when speaking of the definite *coagula* of sols. This is not the case, however. Any substance which resembles a jelly in appearance is called "gel," although in chemical and physical properties it may be entirely different from the kind of matter which Graham had in mind when he invented the term. This use of the expression is exceedingly popular and would be very difficult to overcome.

Let us take up a case or two to show how unscientific this latter usage of the term is. For example, consider the dissolution or dispersion of gelatine in hot water. It forms a very mobile "solution" or rather dispersion, and in this form is called a hydrosol or sol. If this hydrosol be allowed to cool, it becomes very viscous and "sets" to a jelly-like mass. In this stiffened form it is popularly known as a "hydrogel" or "gel." If it be warmed again its viscosity decreases, it becomes mobile and is called a "sol." Now if this use of the term "gel" (which is not as Graham intended) is to be permitted, then what is the line of demarcation between the sol and gel states? A change in state has occurred, it is true, for in the sol condition the water was the external phase whereas in the so-called gel state the gelatine became the external phase and the water internal. The change is very gradual, however, and our change of terms to suit the change in appearance of the system is exceedingly arbitrary and unscientific. Furthermore no chemical change in the nature of the gelatine has taken place.

If some alum or a trace of mercuric chloride be added to the gelatin hydrosol, a coagulum is obtained which is correctly termed a gel according to Graham.

---

[*] Department of Chemistry, Columbia University. From the Journal of the American Leather Chemists' Association.

This is a coagulated compound, however, a chemical reaction has taken place. It will not redissolve in water and is, therefore, entirely different from the case discussed above, which is also commonly called gel.

To further complicate matters, the dry pieces of gelatine (and in fact any other colloid which will "dissolve" readily) which were used to make the original sol are also quite commonly called "gel.' Lottermoser called attention to this several years ago and suggested that such pieces of gelatine, or of any other dry "soluble" colloid be called "solid sol." This suggestion is obviously bad. Why apply any special term at all?

When a hydrous ferric oxide sol is allowed to evaporate spontaneously, it will go through a jelly-like stage and finally become a hard scaly residue when all or nearly all of the water has left it. The jelly-like form will redisperse when warmed with an excess of water, while the amorphous form will not. Yet both forms are called "gel!" Zsigmondy distinguishes between these two different forms by calling the first one "hydrogel" and the second, "gel."

A review of the texts on colloidal chemistry shows the following conceptions of this term.

Cassuto[2] calls a gel the gelatinous precipitate obtained from a sol by means of an electrolyte, heat or evaporation; *i. e.*, a gel is formed by coagulation of a sol. He calls stiffened sols (or jellies), "gelatines."

Bechold[3] remarks the loose use of the word "gel" and states that he restricts it to the description of the coagula from sols. To the stiffened sols or jellies he applies the term "Gallerte," which in English might be called "jelly."

Freundlich[4] says that systems of solid dispersion media and liquid dispersed phase are gels as distinguished from the reverse which are suspensions or emulsions. In other words he applies the word "gel" to jellies.

Hatschek[5] refers to the fact that Graham applied the name "gels" to the products obtained by the coagulation of sols, but later on in his book he calls jellies, gels also.

Ostwald in his "Handbook of Colloid Chemistry," considers all colloids as gels when the system becomes "microscopically heterogeneous." That is to say, he applies the term promiscuously.

Taylor[6] uses "gel" in the same loose general manner as Ostwald, Hatschek and Freundlich.

Zsigmondy in his "Kolloidchemie," limits the word "gel" to the dry residue which will not redisperse in a solvent, but he applies "hydrogel" to the jelly-like mass formed by removal of the dispersion medium or by salt coagulation.

Hardy[7] recognized the difference in properties of substances called "gels" and he qualified the term—"gels by coagulation" and "gels by stiffening."

I feel confident that Graham did not apply this term as loosely as is popular at the present time. In his remarks on the properties of colloidal tungstic acid[8] he says: "It is remarkable that the purified acid is not pectized by acids or salts even at the boiling temperature. Evaporated to dryness, it forms vitreous scales, like gum or gelatine." Note that he describes the dry residue as "scales, like gum or gelatine" and not as gel.

It is evident, then, that the original meaning of the term gel has not been adhered to and in fact is more often applied to the state best described as jellies. Shall we adhere to Graham's definition or shall we discard it, restricting the term gel and its modifications to jellies, as popularity favors, and do away with any special terms to describe coagula from sols by electrolytes, or residues formed by evaporation to dryness? Special terms to describe these last two cases are obviously unnecessary and serve only to encumber colloid chemistry.

Use of "Peptization."

Lately the word "peptization" or "peptinization," as originated by Graham, has shown tendencies of wider use than formerly. Graham used this expression to describe the formation of a sol from a gel by the influence of a small amount of foreign reagent as, for example, the formation of a hydrous ferric oxide sol from a coagulum of ferric hydroxide by treatment with a small amount of hydrochloric acid or ferric chloride. He named it "peptization" because it resembled the hydrolysis of egg white to peptone by acid.

Cassuto, Hatschek, von Weimarn and Zsigmondy preserve the original sense of this term. Bancroft[9] has recently proposed, however, that we use peptization to describe all cases of transformation of gel (using this term in the present popular sense) to sol and not restrict it merely to cases where a foreign electrolyte has been added to accomplish the change; *e.g.*, when dry gelatine is "dissolved" in water Bancroft would call it a case of gelatine being peptized by water. This usage has its merits because it eliminates the word "dissolve" and the implication of "solution."

Ostwald defines peptization as the phenomenon opposed to coagulation.

Taylor prefers a new term, "solation," which he applies to all cases of gel ➔ sol transformations, and incidentally he urges the adoption of "gelation" to define all cases of sol ➔ gel transformations instead of coagulation or pectization.

"Pectization," another of Graham's terms, is rapidly dying out. The word "coagulation" covers all cases of pectization and therefore why preserve an unnecessary term? Furthermore, why adopt the new term "gelation" proposed by Taylor. "Coagulation" is adequate. Of course, if it is decided to name jellies (stiffened sols) "gels," then the word "gelation" would be a good one to describe the "setting" of the gel or the stiffening of the sol.

Elimination of Synonymous Terms.

Elimination of some synonymous terms is decidedly necessary from the list of names applied to the two more or less distinct classes or systems of colloid dispersions. For example, these two systems are variously named as follows:

Autbors		
Noyes[10]	Colloidal solutions	Colloidal suspension
Hardy,[11] Zsigmondy[12]	Reversible colloids	Irreversible colloids
Billitzer[13]	Baser collodis	Typical or genuine colloids
?	Hydrophilous colloids	Anhydrophilous colloids
Henri[14]	Stable colloids	Unstable colloids
Perrin, Freundlich,[15] Neumann[16]	Lyophilic colloids	Lyophobic colloida
Eary[17]	Dissolving colloids	Electrical colloids
Wo. Ostwald[18]	Emulsion colloids	Suspension colloids
von Weimarn[10]	Emulsoids	Suspensoids
Burton[20]	Gelatinizing type	Non-gelatinizing type

The terms "emulsoid" and "suspensoid" are very popular. "Lyophilic" and "lyophobic" are very expressive. The "stable-unstable" and the "reversible-irreversible" terms should be abolished, since they describe the conduct and changes in state of colloids when subjected to external conditions and are not always sharply defined. For example, hydrous ferric oxide sol is fairly stable in the presence of neutral electrolyte (much more so than colloidal gold or platinum), while it is irreversible when evaporated to *dryness*. Most writers classify it with the suspensoids, although Taylor calls it an emulsoid (since if it be evaporated *not quite* to dryness it is partially reversible). In reality it belongs to neither of these two generally accepted classes; its properties place it midway between the two, nearer the suspensoid than the emulsoid class. All the hydrous oxides of the basic or acidic elements act similar to hydrous ferric oxide.

On account of this confusion of classification Bancroft[21] has suggested that the distinction between these two groups be done away with. He prefers to classify colloidal systems according as to whether water or the more mobile phase is the internal or the external phase and states: "While we are reasonably sure that colloidal gold is a solid and that colloidal oil is a liquid, the two behave exactly alike when both are suspended electrically."

This suggestion is along the proper lines, but is too sweeping, since colloidal gold and colloidal oil do not behave alike.

After a consideration of all the terms, it would seem that "lyophilic" and "lyophobic," or their more special derivatives, "hydrophobic" are the least objectionable terms, since most colloids answer to one of these designations. When our knowledge of colloids becomes exact enough to *sharply* differentiate between these two classes then we may find names for those systems which now seem to have properties which place them in neither of the above.

Before concluding, attention is directed to the irritating, although not very serious, mistake in the translations of the German terms "disperse" and "dispersions Mittel" by some authors. The German adjective "disperse" is "dispersed" in English, not "disperse," and "disperse Phase" is dispersed phase," while "dispersions Mittel" is "dispersion medium" and not "dispersion means." These mistakes are like the old one of translating "Wanderung der Ionen" "wandering of the ions" instead of "migration of ions."

References Used in the Foregoing.

[1] *Proc. Roy. Soc.*, 13, 337 (1864).
[2] "Die Kolloide Zustand der Materie."
[3] "Kolloide in Biologie und Medizin."
[4] "Kapillarchemie."
[5] "Introduction to the Physics and Chemistry of Colloids."
[6] "Chemistry of Colloids."
[7] *Z. physik. Chem.*, 33, 326; 385 (1900).
[8] *L. c.*, p. 340
[9] *J Phys. Chem.*, 20, 85-117 (1916.)
[10] *J Am. Chem. Soc.*, 27, 85 (1905).
[11] *Proc. Roy. Soc.*, 66, 95 (1900).
[12] "Kolloidchemie."
[13] *Z. physik. Chem.*, 45, 307 (1903).
[14] *Z. physik Chem.*, 51, 29 (1905).
[15] "Kapillarchemie."
[16] *Koll. Z.*, 3, 80 (1908).
[17] *J. Chim. Phys*, 10, 437 (1912).
[18] "Handbook of Colloid Chemistry."
[19] "Grundzüge der Dispersoidchemie."
[20] "Physical Properties of Colloidal Solutions."
[21] *J. Phys. Chem.*, 18, 549-558 (1914).

New Sources of Fertilizing Elements

(*Continued from page 335*)

amounts to about three pounds per barrel of cement, or to about 60 per cent. of the total potash that enters the kilns. This is now separated by leaching from the rest of the dust with which it is collected, and is placed on the market in the form of a concentrated salt containing about 80 per cent. of potassium sulphate. At other plants, as the Security Cement & Lime Company, the potash is not separated from the dust, but the mixture of both is disposed of directly as collected for use in the manufacture of fertilizers.

In an investigation recently completed in the Bureau of Soils, it was shown that the potash that escapes from the different cement plants of the country varies from 0.35 to 5.34 pounds per barrel of cement, with an average of about 1.9 pounds. Taking 90,000,000 barrels as the average annual production of cement in this country, then it may be estimated that the total potash escaping from all the cement plants of the country as at present operated amounts to about 86,000 tons annually. Assuming, in the light of results already obtained, that it would be possible to recover in available form, say, 80 per cent. of the total escaping, then the available potash that would be possible of recovery in the cement industry of this country amounts to about 75,000 tons annually.

It has been shown, moreover, that the amount of potash that escapes from cement plants may be increased by increasing the percentage occurring in the raw material or by increasing by chemical or other means the percentage of potash volatilized. If the same relative increase in the potash volatilized could be effected in all plants as has already been secured in some plants where potash is now being recovered, then the available recoverable potash in the cement plants of the country would be increased from 70,000 tons to about 100,000 tons annually. Still greater possibilities are to be expected by the use of feldspar and other potash minerals in the raw materials, and it is for reasons such as these outlined that the cement industry is looked upon as one of the principal potential sources of potash supply in this country.

(*Concluded on page 342*)

INORGANIC CHEMICAL SYNONYMS

A Novel Work of Reference for Student and Chemist

By

ELTON R. DARLING*

Readers Who Have Been Following This Compilation Will Be Interested to Learn That in Response to Numerous Requests, a Cross-Index to the List Will Follow Next Month. The List Is Completed in This Issue.

Part VI.

Zinc, 65.37.

Zinc melts at 419° C. and boils at 918° C. It has a valency of two.

An alloy of zinc and copper was known to the ancients, who believed it to be a peculiar form of copper. It was not until the year 4 B. C. that Aristotle discovered that this metal could be prepared from copper and a peculiar earth found on the shores of the Black Sea. To this product Dioscorides and Pliny gave the name "Cadmia."

In the writings of Paracelsus (1520) we find zinc spoken of as a metal and it is to him we give the credit of its discovery as such.

Zinc Chloride, 136.29
- *Zinci Chloridum*
- *Butter of Zinc*
- *Muriate of Zinc*

Zinc Oxide, 81.37
- *Zinci Oxidum*
- *Flowers of Zinc*
- *Nil Alba*
- *Nil Album*
- *Oxide of Zinc*
- *Zinc Powder*
- *Zinc White*

Zinc Sulfate, 354.80
- *Zinci Sulfas*
- *Salt of Vitriol*
- *White Copperas*
- *White Vitriol*

Miscellaneous Synonyms.

Aerugo—*Basic Carbonate of Copper.*
Alkaline Pink Mordant—*Sodium Aluminate.*
Alkaline Red Mordant—*Chloride and Sulfate of Zinc.*
American Vermillion—*Basic Lead Chromate.*
Anardonis Green—*Hydrated Chronium Sesquioxide.*
Basic Chloride—*Antimony Oxychloride.*
Bay Salt—*Sodium Chloride.*
Black Salt—*Impure Sodium Carbonate.*
Blanguette—*Crude Soda.*
Blue Sympathetic Ink—*Solution of Cobaltous Chloride.*
Blue Verditer—*Hydrated Cupric Oxide.*
Bone Earth—*Crude Calcium Phosfate.*
Bremen Blue—*A mixture of Copper Hydrate, Carbonate, and Oxychloride.*
Bronze Liquor—*Solution of Magnesium Chloride.*
Burnett's Fluid—*Solution of Zinc Chloride.*
Chemic—*Solution of Bleaching Powder.*
Chinese Red—*Basic Lead Chromate.*
Chromate Red—*Basic Lead Chromate.*
Cobalt Blue—*A mixture of fused Cobalt Phosfate.*
Donovan's Solution—*A solution of Arsenious and Mercuric Iodides.*
Dung Salt—*Sodium Arsenate.*
English Powder—*Antimony Oxychloride.*
Emerald Green—*Aceto-Arsenite of Copper.*
Freezing Salts—*Calcium Chloride.*
Fumerole—*Crude Boric Acid.*
Fusible Salt—*Ammonium Phosfate.*
Goulard Water—*A solution of Subacetate of Lead.*
Hard Lead—*Mixture of Lead and Antimony.*
Hepar Sulfuris—*A mixture of Dipotassium Trisulfide and Potassium Sulfate.*
Homberg's Pyrophosforous—*Carbonized mixture of Alum and Sugar.*
Lanarkite—*A mixture of Lead Sulfate and Lead Carbonate.*
Laughing Gas—*Nitrous Oxide.*
Lithopone—*A mixture of Barium Sulfate and Zinc Sulfide.*
Liver of Sulfur—*A mixture of Dipotassium Trisulfide and Potassium Sulfate.*
Magnetic Oxide—*Ferrous-Ferric Oxide.*
Massicot—*Lead Monoxide.*
Mendipite—*Lead Oxychloride.*
Mineral Orange—*Lead Tetroxide.*
Meerschaum—*Magnesium Silicate.*
Metallic Oil—*Chloride of Antimony.*
Metallic Oil—*Chloride of Arsenic.*
Paris Green—*Aceto-Arsenite of Copper.*
Patterson's White Lead—*Lead Oxychloride.*
Persalts of Iron—*The Ferric Salts.*
Pickling Liquor—*Impure solution of Ferrous Sulfate.*
Pink Crystals—*Manganese Chloride.*
Prosalts of Iron—*The Ferrous Salts.*
Powder of Algaroth—*Antimony Oxychloride.*
Red Liquor—*Impure Caustic Soda.*
Red Prussiate—*Potassium Ferricyanide.*
Rhodanate—*Alumina Sulfocyanide.*
Ruducite—*Sodium Hydrosulfite.*
Sal Gem—*Sodium Chloride.*
Sal Mixte—*Mixture of Magnesium Sulfate and Sodium Chloride.*

---

*All rights of publication in book form reserved by the author. Research Textile Chemist, 251 Clifton Place, Brooklyn, N. Y.

Salts of Alembroth—*A mixture of Mercuric Chloride and Sal Ammoniac.*
Salt Perlate—*Sodium Acid Phosfate.*
Salt Sedative—*Boric Acid.*
Salts of Sorrel—*Oxalic Acid.*
Salts of Tin—*Stannic Chloride.*
Schlippe's Salt—*Sodium Sulfantimoniate.*
Schleele's Green—*Copper Arsenite.*
Smalls—*Native Iron Sulfide.*
Samlt—*Ground Potash Cobalt Glass.*
Soda Chem—*Solution of Sodium Hypochlorite.*
Terra Verda—*Earth Pigment containing Ferrous Silicate.*
Tincal—*Sodium Borate.*
Tinkal—*Crude Borax.*
Tin Oil—*Stannous Chloride and Oleic Acid.*
Tin Stone—*Stannic Oxide.*
Turner's Yellow—*Lead Oxychloride.*
Verdigris—*Basic Copper Acetate.*
Weldon Mud—*Acid Calcium Manganite.*
White Paste—*Copper Sulfocyanide.*
White Precipitate—*Mercuro-Ammonio Chloride.*
Yellow Liquor—*Polysulfides of Calcium and Sodium.*
Yellow Prussiate—*Pottassium Ferrocyanide.*
Yellow Wash—*A mixture of Mercuric Chloride and Lime Water.*

Hydrogen Compounds

- Hydrogen Dioxide, 18.01
  - *Hydrogenii Dioxidum*
  - *Hydrogen Peroxide*
  - *Peroxide*
  - *Bleach Liquor*
- Hydrogen Chloride, 36.47
  - *Hydrogenii Chloridum*
  - *Hydrochloridum Acidum*
  - *Chlorhydric Acid*
  - *Hydrochloric Acid*
  - *Muriatic Acid*
  - *Spirits of Salt*
- Nitro-Hydrochloric Acid
  - *Acidum Nitro-hydrochloricum*
  - *Nitro-Muriatic Acid*
  - *Aque Regia*
- Hydrogen Borate, 62.02
  - *Acidum Boricum*
  - *Boric Acid*
  - *Boracic Acid*
- Disulfuric Acid, 170
  - *Disulfurum Acidum*
  - *Fuming Sulfuric Acid*
  - *Nordhausen Sulfuric Acid*
  - *Nordhausen Oil of Vitriol*
  - *Pyrosulfuric Acid*
- Hydrogen Nitrate, 63.02
  - *Hydrogenii Nitras*
  - *Acidum Nitricum*
  - *Nitric Acid*
  - *Aqua Fortis*
- Hydrogen Sulfate, 98.09
  - *Hydrogenii Sulfas*
  - *Acidum Sulfurum*
  - *Sulfuric Acid*
  - *Oil of Vitriol*
- Hydrogen Phosfate, 98.14
  - *Acidum Phosforicum*
  - *Common Phosforic Acid*
  - *Phosforic Acid*
  - *Orthophosforic Acid*
  - *Tribasic Phosforic Acid*

[THE END.]

Fertilizing Elements

(*Concluded from page* 340)

Since fertilizers are food for plants it will follow that plants, and particularly certain parts of plants, may serve as fertilizers for a new crop. At one time a plant waste known as cottonseed meal, obtained in the manufacture of cottonseed oil, constituted the largest single source of nitrogenous material used in fertilizers, and the quantity still used for this purpose is in excess of 300,000 tons annually. A case of this kind is seen in the recovery of potash as a by-product in the manufacture of nicotine from tobacco waste. This is another illustration of the use as a fertilizer of a waste product recovered in the utilization of a waste.

Summing up, it may be stated that industrial wastes furnished about 40 per cent. of the potash, 8 per cent. of the phosphoric acid, and 85 per cent. of the nitrogen used in this country in 1916.

The potash was obtained from such wastes as tobacco stems, cottonseed hulls, hardwood ashes, wool washings, blast-furnace flue dust, cement flue dust, and sugar residues; the phosphoric acid was furnished by such materials as bones, shells, fish scrap, and basic slag; and the nitrogen was obtained from wastes in the manufacture of castor, linseed and fish oils; from animal wastes, as blood, hair, horns, hoofs and hides; from leather and wool wastes; from coke; and from a long list of other substances.

GAS

Why Be Without It?

It will doubtless be of interest to chemists and many of our readers to know that The Detroit Heating & Lighting Co., Detroit, Michigan, are manufacturing what is called the Detroit "Combination" Gas Machine.

The gas machine automatically manufactures from gasoline—without the use of artificial heat—a gas which is used for every purpose where public coal gas is used and the cost is no greater. Among some of the many uses of this gasoline-gas is: operating bunsen burners in the laboratory, blast lamps, muffle furnaces, bunsen liquids and in the machine shop for annealing, tempering, soldering and other uses.

(*Concluded on page* 357)

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By CARLETON ELLIS and A. A. WELLS[*]

Part XVI

As installed in the laboratory the lamp case described in the preceding installment of this article is provided with a flue which passes up into the ventilator of the chemical hood. This flue is not necessary when the lamp is used in connection with the beaker described above. When used without the beaker, however, the ozone produced makes the laboratory a very unpleasant place in which to work, unless some means are provided for carrying the exposed air out of the room. The flue also disposes of a great deal of heat.

It is difficult to give an accurate description of the intensity of the light produced. Judging from the current density the light is much more intense than that produced by any lamp which has been previously described. Perhaps the following statement will serve to give an idea of the efficiency of the lamp in producing ultra violet rays: It is known that egg-white is slowly coagulated by ultra violet rays. Bovie states that in order to test the lamp, egg-white was diluted with water to make a 2% solution. The solution was brought to its isoelectric point and filtered clear; 100 cc. of the filtrate were placed in the beaker of the lamp, and the stream of water passing through the water-jacket was adjusted so that the solution of egg-white had a temperature of 16°. A flocculent coagulum began to appear 4 min. after the lamp was lighted. In this experiment the lamp was carrying a current of 11 amperes. (The amount of light probably varies as the square of the current density.)

Data on the expansion of fused quartz are given by *Henning* (Ann. Physik. 1903, (iv), 10, 446; J. Chem. Soc. 1903, Abs., *84*, ii, Page 272) for temperatures up to 1000°. It is found that the mean increase of unit length for a rise of 1° is 0.00000054.

Patent Leather.

An apparatus for the treatment of patent leather with ultra violet light is recommended by *Priest* (U. S. Patent 1,262,977, April 16, 1918, J. S. C. I., 1918, 343A), who states that after leather is coated with the linseed oil varnish mixture customarily employed, the stock is exposed to the direct rays of the sun for a period of 8 or 10 hours. The drying takes place best in clear, cool weather, and is greatly retarded by a humid atmosphere. In order to dry the leather rapidly, Priest uses ultra violet light, which accomplishes the drying operation in from 2 to 6 hours. An apparatus employed by Priest is shown in *Fig. 1*. A frame arranged on bearings so that it may be revolved serves as a support for the hides which are to have their varnished surfaces exposed to the direct action of the ultra violet rays. A series of quartz burners are arranged vertically in the center of the revolving frame. The frame is placed in a drying room having heating coils and heated air may also be introduced through a pipe entering the revolving frame at the bottom. The action of the ultra violet rays may also be supplemented, according to Priest, by the use of ozone.

Ozone Apparatus.

The production of ozone by ultra violet light, as practised by *Potter* (U. S. Patent No. 854,965, May 28, 1907) involves the use of a form of apparatus shown in *Fig 2*. A mercury silica lamp is inclosed by a double walled jacket. A current of air is passed through the inner annular space next to the lamp, while water is supplied to the outer space for cooling purposes. The inner wall of the jacket may be of silver, glass or other reflecting material which will serve to protect the operator from any ill effects of the rays.

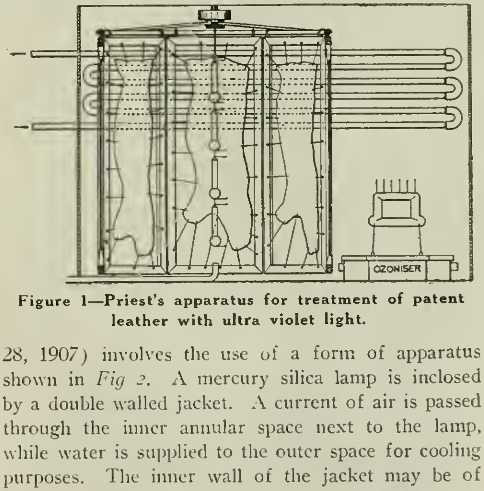


Figure 1—Priest's apparatus for treatment of patent leather with ultra violet light.

Chloroform and Other Chlorides of Methane.

Bedford (J. Ind. Eng Chem., 1916, *8*, 1090) has made some interesting observations on the chlorination of methane, which while strictly speaking do not involve the use of ultra violet light, nevertheless are indicative of methods which may be advantageously employed in carrying out some reactions through the agency of ultra violet light. He observes that one volume of chlorine in seven volumes of natural gas will react quickly in the presence of light from the "White Flame Arc" (Mott and Bedford, J. Ind. Eng. Chem., 1916, *8*, 1029), but without explosion. If reactions with fresh quantities of chlorine be repeated, the speed of the reaction finally slows down as the residual gas becomes diluted with chlorine, hydrogen chloride, nitrogen, air, etc., until finally no more reaction will take place without the aid of external heat.

---

[*] All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

The effect of concentration of free chlorine on the chlorination of methane was studied in the following manner: Natural gas was confined in a bell jar over water at about 20°C. and chlorine was added by bubbling it in through the water. A uniform mixture of the gases was obtained by shaking the jar and splashing the water. The access of diffused daylight, during the short period, produced little or no reaction as long as the percentage of chlorine in the gases was low. Upon suddenly exposing to the light from the "White Flame Arc" there was an instantaneous expansion of the gases, even when the chlorine content was small. After the reaction, the water was shaken up through the gases, thereby cooling them, removing the hydrogen chloride and condensing such reaction products as were liquids at the temperature of the water.

Fig. 3 shows the results reported by Bedford on chlorinating natural gas, while the latter was confined over water at room temperature, the chlorine being added in increments of either 500, 250, or 125 cc. After mixing the gases, they were exposed to the light and then cooled by shaking up with the water. After each cycle of operations, the volume of the residual gas was noted and its contraction from the original gas volume calculated. Before the experiments were started, the water was saturated with chlorine and with natural gas; the slight increase in temperature of the water, during the reaction was found to aid rather than hinder the process. Starting with three liters of natural gas, there was always an unreactive residue of about 200 cc., showing that about 2,800 cc. would react with the chlorine under these conditions.

The horizontal dotted lines in *Fig. 3* represent percentages of the total contraction obtained and aid in the study of the curves. The vertical dotted lines represent volumes of chlorine equal to and twice the total contraction in gas volume.

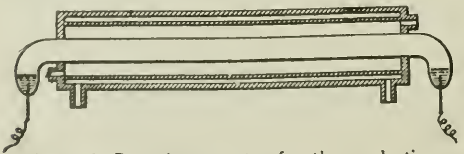


Figure 2—Potter's apparatus for the production of ozone.

Ice As a Cooling Agent.

The attempt to obtain better cooling in order to prevent entirely the formation of tetrachloride, finally led to the carrying out of the reaction in the interstices between cakes of ice. It was predicted by Bedford that by filling the reaction chamber with cracked ice, he should obtain only the di- and tri-substitution products, since methyl chloride is a gas at the temperature of ice and the others should condense out before forming the tetrachloride.

The first experiment in the chlorination of methane in the spaces between cracked ice presented the difficulty of improper gas circulation. The gases directly exposed to the light would react at once but further action took place only as the chlorine slowly diffused toward the light. The content of chlorine was increased until with a mixture of 4 vols. chlorine: 1 vol. methane, an explosion resulted, even in the presence of ice cakes the size of hen's eggs or smaller. After Bedford had made many variations in the apparatus, the one shown in *Fig. 4* solved the difficulty.

An 8-liter, two-neck Woulfe flask, with the bottom removed, was placed over a single ice cake chipped to nearly fill the flask. As the ice melted in the top of the reaction chamber, the flask settled upon it keeping ice in the top of the chamber where the cooling is most needed, until the bottom of the flask touched the bottom of the vat, whereupon the ice melted away from the top of the flask and allowed gradual increase in the volume as well as in the temperature of the gas above, until carbonization took place. The dotted lines show the points of highest temperature as shown by the melting of the ice. Upon starting the reaction, by means of the White Flame Arc light, with the chlorine content of the gases about 1 in 8, the circulation was found to be rapid and violent. The gases passed upward on the side next to the light, drawing the cold gases from around the ice cake below. It was found that 2.6 cu. ft. of natural gas gave 166 cc. of reaction product which is equivalent to about 17 gal. per 1,000 cu. ft. This included the methylene chloride and chloroform dissolved in the water, which were separated by distillation.

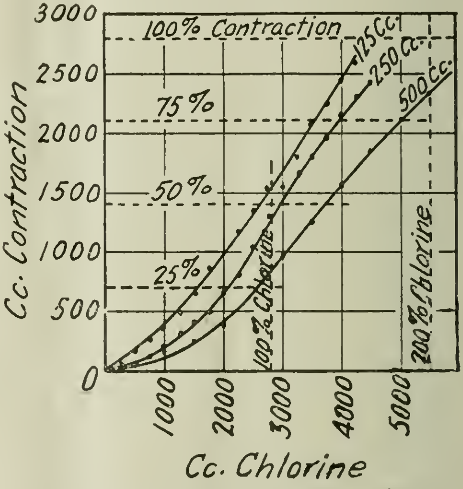


Figure 3—Graph showing Bedford's results on chlorination of natural gas.

The apparatus shown in *Fig. 5* was designed to prevent the access of light to the large volume of gas left in the top of the reaction chamber by the melting of the ice and also to furnish a larger supply of ice per charge. A 10 in. sewer pipe "tee," with the side outlet near the bell end, was supported on three bricks and set in a vat of water. The side outlet was closed with a circular piece of plate glass sealed in with litharge-glycerine cement. The tile was filled with pieces of ice the size of coconuts or larger and the top closed with a wooden lid made gas-tight by rubber coverings. After removing the air by suction through an opening in the lid, natural gas and chlorine were admitted at the same relative points as in *Fig. 4*. The capacity of the tile was found to be about $3\frac{1}{4}$ cu. ft. of gas per hr. and a total of 18.5 cu. ft. gave 1.1 liters of product having the following composition by volume (percentages).

Methylene Chloride	Chloroform	Carbon Tetrachloride	Ethane Products
35.5	47.5	4.0	13.0

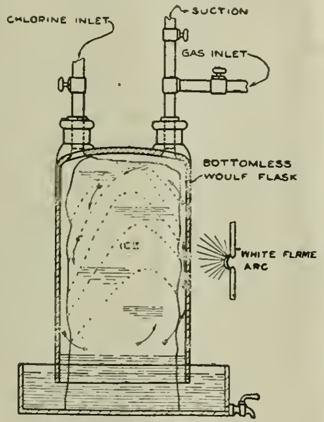


Figure 4—Bedford's apparatus for the chlorination of methane.

Fig. 6 shows a large wooden reaction chamber, 28 in. by 28 in. by 44 in. inside dimensions, built for the carrying out of the reaction on a larger scale, and practically duplicating that of *Fig. 5*. In one experiment using 250 cu. ft. of natural gas, the rate of consumption varied from 14 to 30 cu. ft. per hr. and several gallons of product resulted. The analysis of the liquid reaction product separating out under water was as follows, percentages being by volume:

Methylene Chloride	Chloroform	Carbon Tetrachloride	Ethane Chlorides
35	35	5	20

The analysis of the part soluble in the water and separated by distillation was:

Methylene Chloride	Chloroform	Carbon Tetrachloride	Ethane Chlorides
61	28	1.5	6

About 14 per cent. of the reaction product dissolves in the water produced from the melting of ice by the heat of the reaction. This soluble portion may be entirely recovered by distilling off 5 per cent. to 10 per cent. of the water, the methane chlorides coming over with the distillate, and the residue being about a 5 per cent. solution of hydrochloric acid provided no water has been added except that produced by the melting of ice. About 135 lbs. of ice are necessary for the production of one gallon of product having the composition as given above and the HCl from the reaction is thereby greatly diluted.

In the chlorination of pentane, *Brooks, Smith* and *Essex* (J. Ind. Eng. Chem. 1918, 511) found that once the chlorinating action had started it would proceed very smoothly in diffused daylight, and that ultra violet light was not necessary to effectuate the reaction.

Molecular Rearrangement.

Bodforss (Ber., 1918, *51*, 214) found that Benzoylphenylethylene oxide, benzoyl-m-nitrophenylethylene oxide, and benzoyl-p-chlorophenylethylene oxide undergo rearrangement into phenyl a-hydroxystyryl ketones with increasing readiness when their methyl-alcoholic solutions are exposed to the light of a mercury lamp. The yields of the isomerides are very small, but their presence can be demonstrated by the ferric chloride test for enols and by the precipitation of copper salts, from which they can eventually be isolated.

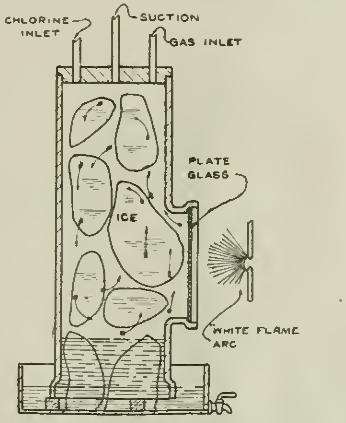


Figure 5—Modification of Bedford's apparatus, designed to eliminate light.

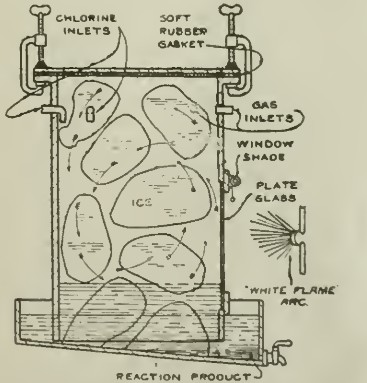


Figure 6—Bedford's design for large scale chlorination of methane.

Lamp for Bacteriological Purposes.

A form of quartz tube mercury lamp recommended by *Knipp* (Phys. Rev., *30*, May, 1910, 641) for bacteriological work is shown in *Fig. 7*, which illustrates the tube and manner of mounting. The diameter of the main branch AB is 25 mm., and the length of the straight portion 15 cm. It had, as used in *Fig. 7*, three outlets. The tubes AM_1 and BM_2 are 20 cm. long and 4 mm. internal diameter, while the exhaust nipple *mn* was somewhat smaller in diameter. The tube was hung on two asbestos-covered pegs mounted on a suitable support. Glass extensions M_1E_1 and M_2E_2 were added of sufficient lengths to support the barometric columns AE_1 and BE_2 respectively. Mercury seals insured tight joints at M_1 and M_2. The vessels E_1 and E_2 served also as the leading-in terminals to the arc. After exhausting the tube it was sealed off beyond M_3. The arc was started in the usual way—by lifting E_2 slightly until the mercury would flow from B down to A. The mercury levels at A and B were adjusted readily by raising or lowering E_1 and E_2.

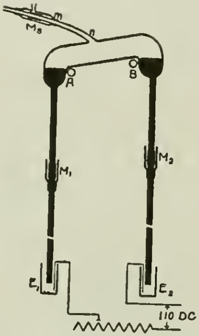


Figure 7—Lamp recommended by Knipp for bacteriological work.

This arc was suited only for low voltages and hence gave out comparatively weak ultra violet radiations. Any attempt to increase the energy consumption would, because of the vapor pressure, depress the mercury electrodes at A and B. In order to obtain a more intense light the shallow vessels E_1 and E_2 were replaced by narrow tubes (about 1.2 cm. in diameter) extending some distance up the barometric legs. This method automatically kept the mercury surfaces at A and B at practically constant levels, and admitted of a small range of light intensity. However, another difficulty was encountered; the increased temperature of the arc interfered with the seal at M_3. In the attempt to obtain a light source of much greater intensity the manner of setting up the tube was changed as follows:

The exhaust nipple *mn* in *Fig. 7* was fused off near the main tube, and instead connection was made below the mercury seal M_1 as shown in *Fig. 8*. This exhaust tube should join the barometric leg at a point *p* far enough down to admit of lowering the seal M_1 A valve protected by a mercury seal is placed at V_3. The lower end of the leg is shaped in the form of an S having a valve V_1 in its outer right-hand limb and a No. 24 Pt. terminal wire sealed into a projection from its middle limb. In the figure, the terminal E_1 is shown in the plane of the paper, while in actual construction it is more conveniently joined to the front. This allows the S to be made more compactly than shown. The opening t_1 to the projection carrying the terminal E_1 should be rather large, otherwise some difficulty may be experienced in filling it with mercury. The length of the leg M_1E_1 must be such as to support a barometric column below the point *p* and thus not interfere with the process of exhaustion.

The leg M_2E_2 as will be seen by the figure is similar to the other with the following exceptions: The point *q* is 760 mm. below the mercury level at B. At *q* is joined a manometer tube about 150 cm. long and 3 mm. internal bore with its upper end *r* open. A mercury reservoir N is joined by a short rubber tube to the outlet below the valve V_1 as shown in the figure.

To operate: Fill the cups shown at the terminals E_1 and E_2 with mercury and connect the same through a suitable resistance R and switch S to a 110-volt, or in case very intense light is desired, 220-volt D.C. source. Include an ammeter and voltmeter in the circuit. Now close the valve V_1 and open the Valves V_2 and V_3. Let the outlet below V_1 dip into a vessel F containing mercury. Pour mercury into the reservoir N until the mercury rises above the valve V_2 and then close it. Close *r* with a rubber tube and pinch-cock, and then start the pump. After a few strokes close V_3 and open the Valves V_1 and V_2 slightly. This serves to fill the projections at E_1 and E_2. Repeat the operation if necessary. Now open V_1 and V_2, pour a considerable quantity of mercury into N, open the pinch-cock at *r*, start the pump and then open the valve V_3. After continued pumping the mercury should stand below *p* in the leg AE_1 and at B in the leg BE_2. When the tube AB, upon sparking, is found evacuated sufficiently (and it is well to let the apparatus stand over night before sealing off) close V_1 and pour mercury slowly into N. The mercury will over-

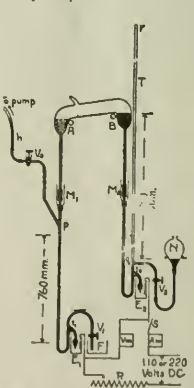
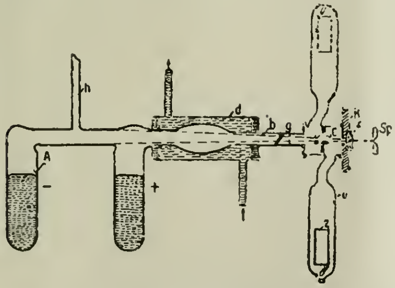


Figure 8—Adaptation of Fig. 7 to production of more intense light.

flow at B and fill the leg AE_1 rising in both branches and "seal off" the system from the pump. When the mercury has reached *h* in the exhaust tube close V_3, and when it has reached A in the main tube close V_2. The quartz tube is now ready to start the arc. Close the switch S and open the valve V_2 only long enough to let a stream of mercury flow from B to A. If properly exhausted the tube should light up at once. As the arc burns the current falls off in value. By keeping the current constant—increasing the impressed voltage—the arc will exhibit the characteristics as described by Küch and Retschinsky (Ann. d. Phys. 1906, *20,* 563) for increasing vapor pressures. The pressure is read by the manometer *qr* and may exceed with safety one atmosphere.

The quartz tube AB may have almost any shape which the needs of the investigation may require, keeping in mind the manner of starting the arc. The electrode B should be comparatively large in area so that a slight depression of the mercury will correspond to a considerable height in the manometer tube *qr*. Either A or B may be the anode. As A fills up, by condensation and also by overflow from B, it may be lowered at will by opening V_1 for a moment. In case the vacuum falls the tube can be exhausted readily again. The valves should be worked dry to avoid contaminating the mercury. To give added strength to the joints at M_1 and M_2, the pure gum tubing used should be wound over with one layer of adhesive tape which in turn should be wrapped with strong thread. The conduction of heat from the electrodes to these joints is not sufficient to injure them even for continued running at high pressures.

Some of the advantages of this form of quartz tube mercury lamp are: Simplicity of the quartz tube; ease of starting the arc and adjustability of the mercury surfaces at A and B; apparatus may be taken apart readily for purposes of cleaning or for introducing different materials into the arc; when properly mounted it is quite portable.

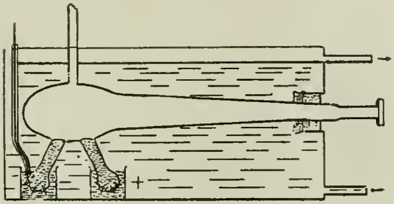


(Photostat copy from N. Y. Public Library.)

Figure 9—Apparatus used by Wolff for study of extreme ultra violet.

Apparatus for Extreme Ultra Violet.

For the purpose of making investigations in the extreme ultra violet *Wolff* (Ann. Physik; 1913 (iv) 42. 825) used a quartz lamp of the Stark and Küch type (Phys. Zeitsch. 1905, *6,* 438) made by Heraeus. (*Fig.* 9) shows the construction of the apparatus. The lamp A has a water-cooled side tube b which is connected with a Geissler tube shown on the right. The latter is closed by a perforated plate K, over which is fastened a fluorite plate f. The tube h of the lamp A is connected to a pump. In order to control the time of exposure and to avoid the presence of metal vapors in the Geissler tube and on the fluorite window, a valve of sheet iron g is arranged in the tube b in such a manner as to be actuated by an electromagnate placed outside the tube.



(Photostst copy from N. Y. Public Library.)

Figure 10.—Another form of lamp used by Wolff.

A modified form of lamp used by Wolff is shown in *Fig. 10*. An elongated bulb of glass is set in a water bath. The bulb has two tubes in the lower side for mercury. An exhaust tube is situated at the top. At the right hand end is placed the fluorite window. The mercury vapor condenses on the walls of the bulb so effectively that the window does not become coated with mercury even after operating for a considerable period. These lamps are started by an induction coil and are operated at 220 volts.

(*To be continued.*)

Beet Sugar Pulp as Cattle Feed

An idea of what is being done by large industrial enterprises in utilizing waste materials is furnished by the annual report of the American Beet Sugar Company. This concern several years ago began converting the pulp which it had previously thrown away into a valuable food for cattle. While for the year ending March 31, 1917, the return from the pulp amounted to $198,022, the net receipts for the succeeding year totaled $314,324, and was more than sufficient to pay the dividend on the preferred stock of the company.

"At Oxnard, Cal," says the report, "after experiments during the last three campaigns, a plant is being erected at an estimated cost of $123,939 to extract from the water which is now run into the ocean, potash, ammonia, etc., the market value of which has advanced so rapidly during the war. This plant, it is expected, will be ready for operation when the factory begins work the coming summer, and it is estimated that the profit on its production this year will exceed its cost, and that hereafter, even with peace prevailing, the value of its product will insure continued profitable operation."

Plans for Chemical Show

(*Continued from page 333*)

tions and needs. Dr. Charles H. Herty and Dr. G. W. Thompson, president of the American Institute of Chemical Engineers, are to make opening addresses. F. J. Tone, president of the American Electrochemical Society; Dr. W. H. Nichols, president of the American Chemical Society, and several others are expected to make addresses also. Joseph W. Richards will speak on "Ferro Alloys of silicon tungsten, uranium, vanadium, molybdenum and titanium." Richards is a member of the Naval Consulting Board. Theodore Swann, president of the Southern Manganese Corporation, will speak on "Ferro Manganese."

The program for the exposition is in active preparation. There will be a series of symposiums on the "Development of Chemical Industries in the United States, notably since July, 1914." This will embrace the period since the beginning of the European war, which because of its removing the source of supply for our domestic industries inspired the development of our own chemical industries that, now, when we ourselves have entered the war, are proving so efficient. This program is divided into a consideration of Potash Development, on which Mr. C. A. Higgins, of Hercules Powder Company, will speak of the operations of that company in its recovery from kelp; Mr. Linn Bradley, of Research Corporation, of its recovery from cement dust and other sources by electrical precipitation.

There are to be other symposiums on chemical engineering, acids, industrial organic chemistry, the cheramic industries, and the metal industries, and among the speakers are:

A. Hough—"Chemical Engineering in Explosives, T N T; T N A; Picric Acid and Nitrobenzol."

E. J. Pranke—"Development of Nitric Acid Manufacture."

S. P. Sadtler—"Development of Industrial Organic Chemistry."

Geo. H. Tomlinson—"Wood as a Source of Ethyl Alcohol."

C. A. Higgins—"Kelp as a Source of Organic Solvents."

Alcan Hirsch—"Pyrophoric Alloys."

The American Ceramic Society, which will hold its meeting at the exposition on Thursday afternoon, September 26, has already upon its program the following:

A. V. Bleininger—"Recent Developments in the Ceramic Industries."

L. F. Barringer—"Manufacture of Electrical Porcelain" (illustrated by motion pictures).

H. Ries—"American Clays."

F. A. Whitaker—"Manufacture of Stoneware" (illuminated).

Following this meeting a series of motion pictures of the ceramic industries will be shown. The motion picture program with the arrangement of which the Bureau of Commercial Economics is again co-operating, carries forward the idea of the symposiums, and pictures will be shown of industries that have developed, in so far as they can be shown with propriety.

There will be shown a series of motion pictures depicting studies of lakes, water falls, and hydroelectric power possibilities. The development of some of these will be carried through the several stages of construction, generation and transmission of the power and its use in industrial operations. Films of several electro-chemical operations will be shown.

There will be pictures of many chemical, mining and related industries, the application of electricity and electrical equipment to industrial work. There will be pictures showing the alkali industries that will be shown the same day on which the potash symposium is held. The making of glass, pottery and stoneware pictures will be shown on Thursday, September 26. Pictures of the oil industries, petroleum, asphalt, fatty oils, soaps, paints, linoleum and oil cloth will be shown. In fact, every field of endeavor from the products within, upon and above the earth with which chemistry deals will be shown. There will be a series of films depicting carelessness, the destruction of life, wealth and resources that show hazards and risks in industrial plants and how they may be overcome. The dangers of fire and explosives will be demonstrated and the prevention of disease of vaccines.

The list of exhibitors of the exposition is a very complete one of the best firms among or supplying the chemical industries, firms who are placing their faith in the future of America and the men who are building to successfully conclude this war and to meet world trade competition after. Many of the exhibitors are supplying motion pictures that will be shown on the program. More complete details of the program, motion pictures and exhibits will be given in our next issue.

While the exposition will bring manufacturers of machinery, equipment, products and supplies together with men who are using them, its chief effect will be to show the people of the country that the chemists of America have made rapid advances in the past year, greater than ever before in this country's history. Much of the success of winning the present war depends upon chemicals and the chemical engineer. The convention will bring to light some of the marvelous results of recent research, and many engineers and experts who hold important positions in the advance of the chemical industry will be speakers at the various industrial conferences. The proceedings will develop matters of timely interest to the public as

(*Concluded on page 355.*)

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors. Synthetic Medicinals, Flavors and Perfumes. Explosives, Photographic Developers.

National Aniline Continues Education of the Consumer

The National Aniline & Chemical Company, Inc., has always extended the facilities of its laboratories and the service of its technical men to the textile and other trades. Such service as this has become an important department in the National organization.

The war with its resultant difficulties has added another problem. In all great crises numerous concerns spring up which are inadequately prepared to handle a business as technical as that of dyestuffs. Goods get upon the market which are not suitable; the textile manufacturer is misled; goods imperfectly dyed or which have been dyed with the wrong color come upon the market; and the public, uninformed as to conditions, finds difficulty in judging between what is good and what is bad. This is particularly harmful to an industry as much needed by America as that of dyestuffs. It therefore has become important that distributors of the finished garment should be informed as to the present color situation.

With this in view the National Aniline & Chemical Company, Inc., is extending to clothiers, department stores, and others, the facilities of its laboratories for the examination and report on any fabric in which they may be interested. The reasons prompting this invitation are fully set forth in the following letter which has been sent to a large number of such merchants:

"In the emergency existing for a few months after the outbreak of the war—the transition period before the establishment in this country of the present great artificial industry—many kinds of worthless dyes were used—in some cases long after it was necessary, and the retailer and distributor of dyed garments commenced a campaign of explanation to the consumer to remove from their shoulders the responsibility of badly dyed fabrics. This explanation was based upon the assumption that in the absence of German dyes good work could not be secured. The explanation became a habit.

"To make such a statement today is untrue, and if continued after an opportunity has been given to investigate might be interpreted as German propaganda. This company and its predecessors have for years invited the mills to submit their problems in dyeing, and the necessary scientific tests and reports have been made without involving the recipients in any obligation. It is proposed now to extend this facility to the garment manufacturers, to the retail dealers and to the department stores.

"To this end we are prepared to make tests of any of your fabrics and to report to you the quality of the dyestuff used; its comparative merits with the dyestuffs used prior to the war; its fastness to light, to washing, and any other requirements which you may be interested in. This will be done without charge, and in accepting such service no obligation is incurred. Our sole object is to demonstrate the comparative merits of American and foreign dyes.

"For your information we hand you two publications of ours which will suggest to you the broad and stable basis upon which this American industry is now building."

Alizarine Red Now Made in America.

In January of this year, the National Aniline & Chemical Company, Inc., made this statement in its house organ, "Dyestuffs": "The interesting things hoped for in 1918 are the placing on the market of alizarine red, or indigo, and of hydron blue. The consuming trade looks forward with expectancy to these accomplishments. Other things are hoped for, but these are promised." The development of synthetic indigo at Marcus Hook was announced some months ago. At the recent textile show in Grand Central Palace the National Company displayed two large globes, one filled with indigo and the other with alizarine. It now announces that alizarine is actually being placed in the hands of the consumers, the first shipments having already gone out.

Up until the beginning of the war the big alizarine industry was almost entirely German. It was in 1868 that two German chemists, Graebe and Lieberman, determined the constitution of the product and succeeded in manufacturing not only alizarine but also purpurine. Upon this investigation also depended a number of subsidiary processes of great importance: the manufacturing of bichromates and fuming sulphuric acid. The discovery of alizarine practically eliminated the entire madder industry, which flourished especially in France, and many hundreds of thousands of acres which had formerly served for the cultivation of madder were now available for foodstuffs. Madder has almost completely disappeared from the markets because it could no longer compete with alizarine in purity, strength, and especially uniformity in quality. There are still some dye houses in Europe which from force of habit prefer madder to alizarine, but it is universally conceded that, especially for the calico printer, alizarine produces results which were not possible with madder.

Alizarine, so named by Robiquet and Colin after "Alizari," the commercial name of levantine madder root, is a derivative of anthracene, which is contained in coal tar. Anthracene is usually oxidized with sodium bichromate and sulphuric acid, and the resulting anthraquinone transformed into a sulphonic acid. The sulphonic acid is then melted with caustic soda and transformed into alizarine in closed vessels under pressure. The chemical name of alizarine is dioxyanthraquinone. It is a reddish yellow powder in its pure state, or appears in brilliant orange red needles at the melting point of 289-290°. It is practically insoluble in cold and very little soluble in boiling water. It dissolves completely with a reddish orange color in boiling alcohol, ether, and carbon disulphide, glycerine, glacial acetic acid, benzone, and turpentine. Cautic soda dissolves it with a bluish violet shade. Muriatic acid precipitates the dyestuff from this solution.

Dyeings produced from alizarine are distinguished by great brilliancy and excellent fastness to light and washing. When applied to cotton in connection with aluminum mordants, the so-called Turkey Red, the fastest red known to the art of dyeing, is produced. It is for this Turkey Red that alizarine has been needed most.

This alizarine of the National Aniline & Chemical Company, Inc., has been developed in the laboratory of its Brooklyn works, where it is now manufactured in a building erected for this purpose. This achievement with that of indigo does much to show the falsity in the position of those consumers who still doubt the ability of the American chemist and manufacturer to equal the product of the German, and to continue to supply the American consumer after the war. This American alizarine is of exactly the same quality in all respects as that formerly imported from Germany. It is now expected that the development of hydron blue, a fast blue for cotton, which is sure to follow, will meet the last objections of the remaining doubters.

National Sulphur Blue L.

This is the latest addition to the series of Sulphur Blue now being manufactured by the National Aniline & Chemical Company, Inc., and places in the hands of dyers a product possessing considerable brilliancy.

This new blue is applied to cotton in the usual manner. Dyeing proceeds uniformly at a temperature of 140° F. The dye bath is charged with a quantity of the dyestuff necessary for the desired shade, together with an equal weight of sodium sulphide concentrated, and also 3 to 5 per cent. of soad ash and 15 per cent. of common salt. Complete reduction of the dyestuff in the bath is noted when the color of the solution changes to a reddish-gray.

National Sulphur Blue L is advantageously aftertreated with metallic salts, which are applied in a separate bath. Those recommended, with this mode of application, are bichromate of soda and acetic acid which slightly reddens the shade. Sulphate of copper (bluestone) and acetic acid dulls the shade, while a combination of bichromate of soda, bluestone and acetic acid produces a shade which is an intermediate between those which are produced with the metallic salts used singly.

Fastness of the dyeings produced with this new type of blue is very good; to *light*, it is very satisfactory and will answer for nearly all requirements; to *ordinary washing*, the shades are excellent, but under the influence of hard washing, the shade loses slightly, although both cotton and wool remain unstained; to *cross-dyeing*, the shade does not lose in depth, but is made slightly duller, but white wool and cotton remain quite clear. The dyed shades are particularly fast to hard fulling.

On the whole, it is a most satisfactory dyestuff, and will be found to meet the requirements of cotton dyers who have been in need of a fast bright blue of this type.

Dyers interested will, upon request, be supplied with full working details, with product sample, and dyeings from any of the company's branches.

Manufacture of 2-Amino-Anthraquinone

The anthracene derivative, 2-amino-anthraquinone, is widely used in the synthesis of vat dyes, notably in the production of indanthrene and its derivatives.

An improved method for its preparation is announced by P. Dutoit, of Monthey, Switzerland, assignor to the Society of Chemical Industry in Basel. (Amer. Pat. 1,255,719, of Feb. 5, 1918.)

The process consists in heating 2-anthraquinonesulfonic acid with ammonia and with an aromatic nitrocompound as, for instance, a nitrophydrocarbon or one of its derivatives. Hereby is obtained, besides the 2-aminoanthraquinone, as valuable secondary product the aromatic aminocompound corresponding to the nitrocompound employed.

The invention is illustrated by the folowing examples:

Example I: In an autoclave are heated 500 gr. of sodium 2-anthraquinonesulfonate with 100 ccm. of water, 1500 ccm. of ammonia of 26 per cent. and 240 gr. of nitrobenzene, for 24 hours at 190° to 200° C. After cooling the content of the autoclave is distilled with steam and 2-aminoanthraquinone, remaining in the form of crystals, is separated by filtration, washed with water and dried. Thus are obtained 290 to 300 gr. of aminoanthraquinone corresponding to an output of 81 to 84 per cent of the theory. By adding common salt to the motherlye small quantities of unchanged sodium anthraquinonesulfonate can be separated therefrom. From the liquid distilled off by the treatment with steam can be obtained about 90 gr. unchanged nitrobenzene and about 90-100 gr. aniline corresponding to the quantity of nitrobenzene consumed.

Example II: For the 240 gr. of nitrobenzene employed in Example I are substituted 440 gr. of sodium nitrobenzenesulfonate. After cooling the content of the autoclave is filtered off and the aminoanthraquinone thus obtained in crystalline form is thoroughly washed with water and dried. From the filtered liquid can be separated, besides unchanged nitrobenzenesulfonic acid, the quantity of anilinesulfonic acid corresponding to the sodium nitrobenzenesulfonate consumed.

Instead of those indicated in the examples, other aromatic nitrocompounds, as for instance, nitrotoluene, dinitrobenzene, nitronaphthalene, dinitronaphthalenes or their sulfoderivatives, etc., can be employed.

Device for the Sulfonation of Aromatic Hydrocarbons

A practical method for the continuous sulfonation of aromatic hydrocarbons has been devised by Hans Bull, of Philadelphia, (Amer. Pat. 1,247,499, of Nov. 20. 1917).

Use is made of the principle of counter-current and the mechanical arrangement is not unlike that of a battery of Shanks' lixiviating vats.

A series of tanks or closed receptacles is mounted one above the other, so that use may be made of gravity. Pipes lead from the bottom of each receptacle to a point half-way up the side of the receptacle immediately beneath. Bent pipes connect the top of each receptacle with the lower portion of the receptacle immediately above.

Sulfuric acid, or oleum, enters at the tops of the series and descends to the bottom by way of the first set of pipes. A hydrocarbon, liquid or dissolved in a convenient solvent such as naphtha, enters at the bottom, and passes upward through the second set of tubes, as the result of its lighter specific gravity.

The purer hydrocarbon thus encounters the less concentrated sulfuric acid and the more strongly sulfonated hydrocarbon meets the more concentrated acid.

The upward current of hydrocarbon, carrying with it the newly formed sulfonic acid, bubbles continuously through the descending current of sulfuric acid, and intimate contact is effected. As a result weak acid is drawn off from the bottom of the lower receptacle while the excess of hydrocarbon, containing most of the sulfonic acid produced, issues from the upper part of the topmost receptacle and is conducted to the separating apparatus.

This device is well adapted for carrying out the method of sulfonation recently patented by Prof. L. M. Dennis, and described in the pages of this journal.

The Manufacture of Chlorobenzene

Chlorobenzene is produced by the action of chlorine on benzene in the presence of a catalyst. The catalyst seems necessary to bring about the substitution of the hydrogen by chlorine. Without its aid, if benzene is acted upon by chlorine, the latter is simply dissolved, giving a yellow solution. After some time, and especially under the action of sunlight, white crystals with a camphor-like odor separate out. These are hexachloride of benzene, $C_6H_6Cl_6$.

If, however, the reaction takes place in the presence of a compound of iodine, iron, molybdenum, or antimony, the result is quite different. The chlorine reacts on the benzene, replacing the hydrogen:—

$$C_6H_6+2Cl=C_6H_5Cl+HCl.$$

It may be noted that the bodies ordinarily employed as catalysts are generally susceptible of two degrees of chlorination, ICl and ICl_2, $FeCl_2$ and $FeCl_3$ for instance. This helps to explain why minute quantities of them only are necessary, as the catalyst serves simply as a carrier for the chlorine.

It is true, however, that other bodies such as aluminum chloride will serve. This is explainable by the fact that there is an intermediary formation of a metallo-organic body which has a greater reactivity than has benzene. Whatever catalyst is used, the action does not stop at the formation of the monochloride; a second molecule of chlorine acts on the monochlorobenzene and transforms it into dichlorobenzene:—

$$C_6H_5Cl+2Cl=C_6H_4Cl_2+HCl.$$

While there is only one monochlorobenzene, three dichlorobenzenes are known. During the chlorination there is a major production of the para derivative, along with a certain quantity of the ortho isomer.

Pushing further the action of the chlorine, the trichloride of benzene is obtained, and notably the asymetric derivative 1:2:4, fusible at 17° C., and boiling at 213° C. Finally, if the action is sufficiently prolonged and energetic, the six atoms of hydrogen are replaced by chlorine and hexachloro-benzene $C_6H_6Cl_6$, which is the ultimate product of the substitution by chlorination, is formed. This is also known as Julin's chloride. The crystals melt at 226° C., and boil at 326° C.

These polychlorides are of no particular technical interest. The monochloride is a largely used product, and its industrial proparation is of constantly growing importance.

By the mononitration of chlorobenzene a mixture is obtained of the ortho and derivatives. They are separated by fractional distillation in a vacuum, followed by fractional crystallisation.

Orthonitrochlorobenzene is the raw material for orthonitro-anisol, from which dianisidine and anisiparatively simple. A standard type is that invented by Marckwald and patented in 1902.

The fundamental idea is to chlorinate fresh benzene as it arrives in the apparatus, drawing off the chloridine are prepared, and from these nitroanisidine, guaiacol, and vanilin are obtained.

The para derivative is the raw material for the manufacture of paranitraniline, formerly prepared by the nitration of acetanilide. It can also be prepared from paranitrophenol and its derivatives.

By dinitration dinitrochlorobenzene 1:2:4, melting at 50° C., is obtained, and this, as already stated, is the raw material for dinitrophenol.

Finally, by tri-nitration, picryl chloride is obtained. This nitration is effected with difficulty, and has found only a very restricted employment. By the hydrolysis of this chloride, picric acid is obtained, but this process seems without technical interest, as it is much easier to prepare the explosive by the trinitration of phenol.

These particulars show the importance of chlorobenzene, the manufacture of which was almost exclusively German before the war, partly owing to the fact that Germany produced huge quantities of liquid chlorine, particularly suitable for synthetic work because of its purity and concentration. The war has led the Allied countries to commence the manufacture of this highly important product, and it is now produced in France, Italy, the United States, England and Switzerland.

As for the extent of the world-wide production, it may be estimated that about 6,000 tons of chlorobenzene are produced from which 15,000 tons of sulfur blacks are obtained. Reckoning another 4,000 tons for all other uses, the production may be put down as 10,000 tons, which is probably above the mark.

At first glance, this manufacture does not appear to offer any special difficulties, but it must be remarked that the technical details of the manufacture are almost non-existent. The majority of books on the subject merely give general indications, without any precision as to the exact method of production.

Technical Chlorination of Benzene

As remarked, the preparation of chloro-benzene is theoretically simple. If the manufacturer has liquid chlorine and crystallisable benzene at his disposal, all that is required is to let the first agent react on the second in the presence of a catalyst—metallic iron for instance, to obtain the reaction already formularised:—

$$C_6H_6 + 2\,Cl = C_6H_5Cl + HCl.$$

This reaction leads to a considerable evolution of heat. It is, therefore, necessary to cool energetically to avoid loss of benzene by evaporation, the more so as the hydrochloric acid liberated also leads to losses if apparatus for the condensation and recovery of the volatile products is not provided. Moreover, an elevation of temperature brings about dichlorination of the benzene, even in the presence of unchanged benzene. It does not seem possible to prepare chlorobenzene exclusively when working with the correct theoretical proportions. A mixture of chlorobenzene with the dichloride is always obtained and a quantity of benzene remains unchanged.

Chlorination, therefore, differs notably from nitration and sulfonation, as in these operations the mono derivative is prepared almost exclusively, without the formation of sensible quantities of dinitrates or disulfonates. Possibly this is because chlorine reacts on benzene with much greater energy than nitric or sulfuric acid by reason of its great affinity for hydrogen.

Therefore, to limit the formation of the dichloride, which has no technical value, the reaction must be moderated by refrigeration, and the chlorination must be conducted in such a manner that there is always an excess of benzene. Practically, it suffices to carry the chlorination to about 60% of the theoretical calculation. As 78 parts of benzene require 71 parts of chlorine, the practice is to use 40 parts of chlorine. This corresponds to an increase of the weight of benzene of 20 parts, as only half of chlorine is fixed, and the other half combines with hydrogen and forms hydrochloric acid.

As an example, the following figures are tabulated, taken from three chlorination experiments, in the presence of 5% of iron, at a temperature not higher than 40° C.

	I.	II.	III.
Benzene	80	80	80
Increase of weight to	89	97	118

Benzene boils at 80.5° C., chlorobenzene at 132° C., paradichlorobenzene at 174° C. Fractional distillation of the three products above came out as follows:—

	I.	II.	III.
To 100° C.	60	35	—
100° to 120°	6	25	—
120° to 140°	23	28	50
Above 140°	—	—	60
Residue	—	9	8
	89	97	118

A fresh fractional distillation gave a neater separation in the second experiment, chlorinated to about 50%. The final results were 35 parts of recovered benzene, 10 parts partly chlorinated, 40 parts of chlorobenzene passing over between 128° and 134° C., and 5 to 10 parts of dichlorobenzene.

The third experiment is particularly characteristic; it shows that if the chlorination is pushed on until the benzene completely disappears, there is a considerable proportion of dichlorobenezene formed.

It will be seen, therefore, that it is necessary to work with the benzene always in excess in order to avoid as far as possible the formation of the dichloride, which is almost valueless. The chloro-benzene is then separated by distillation, and the recovered benzene is chlorinated anew, observing the same precautions as before. In this way, almost all the benzene is transformed into chlorobenzene, and any material proportion of the dichloride is avoided.

Apparatus

Apparatus for the chlorination of benzene is comparatively simple. A standard type is that invented by Marckwald and patented in 1902.

The fundamental idea is to chlorinate benzene as it arrives in the apparatus, drawing off the chlorinated product as it is formed.

The benzol is run into a still surmounted by a column, and provided with a refrigerator, so that the condensed benzene comes into the chlorination chamber at the desired temperature.

The flow of chlorine from a cylinder of liquified chlorine, regulated so as to allow the benzene always to be in excess. The hydrochloric acid formed escapes by a pipe at the top of the chlorination apparatus. As soon as the liquid attains a certain height in the chlorination chamber it is evacuated automatically by a conduit to the still. By proper regulation, the inflow of the benzene and the outflow of the chlorinated product should be equal. Owing to the column and the condenser, only the vapors of benzene arrive after condensation in the chlorinating chamber. As the content of this is much less than that of the still, it is possible to chlorinate almost all the benzene, and, at the same time, to avoid the formation of polychlorides. The major part of the benzene being transformed into chlorobenzene, all that is necessary is to evacuate the chlorination apparatus, and to proceed with the neutralization and distillation.

When the benzene is chlorinated to the degree required, it is distilled, and the diverse fractions are collected. The catalyst remains unchanged in the retort, and serves for a new operation, and the first fractions of benzene are again chlorinated.

A German patent claims that it is advantageous to employ a mixture of oxide of iron and metallic iron as catalyst. With this catalyst there is only a slight elevation of temperature, and there is no necessity to refrigerate.

Marckwald states that for 300 lbs. of benzene, 1 lb. of ferric chloride and 1 lb. of iron, in fine particles, are required, and the benzene is treated with 156 lbs. of chlorine. At the termination of the chlorination, a vacuum is produced, and the distillation follows. In this way, 205 lbs. of chlorobenzene, boiling at 131° to 133° C, is obtained. In addition, there is a fraction consisting of 145 lbs. of a mixture of benzene and chlorobenzene, which is treated again with 30 lbs. of chlorine. This yields 90 lbs. of chlorobenzene, and another fraction of mixed benzene and chlorobenzene of 55 lbs., from which 30 lbs. of chlorobenzene in turn is recovered.

To sum up, by using 300 lbs. of benzene, and employing 230 lbs. of chlorine, 335 lbs. of pure chlorobenzene, 24 lbs. of paradichlorobenzene, and 13 lbs. of sub-products are obtained. In addition there are 115 lbs. of gaseous hydrochloric acid, which yields 380 lbs. of hydrochloric acid at 20°.—*La Revue des Produits Chimiques.*

"NOW MADE IN AMERICA"
This is the True Meaning of

ALMARIN

BRILLIANT MALACHITE CRYSTALS
RHODAMINE B & B EXTRA
CRYSTAL VIOLET 6 B A S EXTRA
BRILL. FUCHSINE CRYSTALS
Guaranteed 100% Soluble

DIAZO BORDEAUX F F
CHRYSOPHENINE G S
DIAMINE FAST LIGHT YELLOW C H
DIAMINE FAST PINK 8 B S
DIAMINE ROSE G S
BENZO FAST SCARLET 4 B A S
BENZO FAST SCARLET 8 B A S
BENZO FAST RED 8 B A L
Fast to Acid Level Dyeing Union Colors
BENZO FAST BROWN
BENZO PURPURINE 10 B S AND 4 B S
BENZO SKY BLUE 6 B A S (stands copper test)
M-ERIKA B
LANA FUCHSINE S L AND 6 B
SULPHUR SKY BLUE K T G

SULPHUR NAVY BLUE & OLIVE DRAB
ALIZARINE NAVY BLUE & OLIVE DRAB
Government Standard

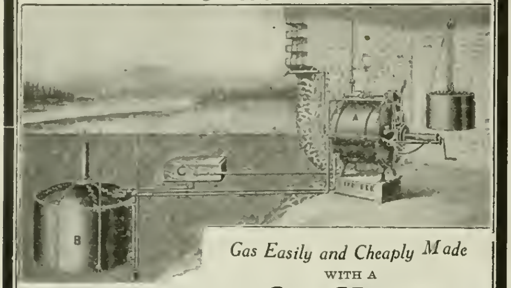
DI-ETHYL ANILINE Guaranteed 99% Pure or Better

Prices for Spot or Contract "From One Pound to a Million" and Samples Cheerfully Furnished

The Almarin Company
MANUFACTURING CHEMISTS
TELEPHONE: CORTLANDT 377 Singer Building, NEW YORK

18 Years of Chemical Progress

MODERNIZE YOUR EQUIPMENT
Use Gas from YOUR OWN Plant
Eliminate Worry About Coal Shortage and Diminishing Supply of Natural Gas



Gas Easily and Cheaply Made
WITH A
TIRRILL "EQUALIZING" GAS MACHINE

for Heating Cooking—Lighting
and all BRANCHES of CHEMICAL INDUSTRIES

Fully guaranteed, easily installed. Affords the *same uses as city gas*. Nothing to get out of order. Does not affect insurance rates.

TIRRILL Combination Mixing Valve
regulates air and gas with one adjustment. Insures maximum of heat with minimum of gas consumption. Adaptable to any kind of gas, and unexcelled for atmospheric burners and apparatus. **Write for FREE Booklet.**

Important.—We are the sole manufacturers of the genuine Tirrill Burners. To avoid getting imitations, order direct from us or write us for the name of the Tirrill dealer in your vicinity.

Tirrill Gas Machine Lighting Co.
Established 1864 619 Terminal Bldg., 103 Park Ave., N. Y.
Sheet metal specialties built to order upon specification.
Let us solve your fuel problems

TIRRILL Combination Mixing Valve

RICHE' ADIABATIC CALORIMETER

Renders exact determinations of caloric and combustion contents. Sold by first class dealers of laboratory supplies. We will gladly send catalog.
We also manufacture light machinery, interchangeable parts, stampings, etc., on special order.

Merit Machine Manufacturing Corporation
465 Greenwich Street, New York

More Manganese from Brazil.

American consumers of Brazilian manganese ore are happy over the announcement that they will now receive increasing quantities of this commodity as a result of the removal of the embargo on the Central Railroad of Brazil.

Law & Co. Take New Headquarters.

Announcement has been made by Law & Co., consulting analytical and engineering chemists and bacteriologists, formerly known as the Picard-Law Co., that they have removed their Atlanta laboratories to the Walton Building, that city. C. M. Stodghill has been appointed head of the mineral and bacteriological departments.

H. A. METZ & CO., Inc.

122 HUDSON STREET, NEW YORK

BOSTON PHILADELPHIA SAN FRANCISCO ATLANTA
PROVIDENCE CHICAGO CHARLOTTE

PRODUCTS:

Dyestuffs, Colors, Intermediates, Sizing and Finishing Materials

Dyestuffs, Colors, Sizing and Finishing Materials — *Produced by* — Consolidated Color and Chemical Co. Newark, N. J.

Dyestuffs and Intermediates — *Produced by* — Central Dyestuff and Chemical Co. Newark, N. J.

Plans for Chemical Show

(*Concluded from page* 348)

well as to the assembled delegates.

The exposition is a war-time necessity and regarding it as such each exhibitor is planning his exhibit so that it will be of the greatest benefit to the country through the men who visit it, all of whom are bent upon a serious purpose—that of producing war materials in large quantities, and constantly increasing this production till the war has been won by the United States and its allies.

Papers covering practically every phase of chemistry and a discussion of steps that will need to be taken after the war, will be presented by leading experts in each branch. Pressing chemical problems concerning many of the chief articles of domestic and foreign commerce will be taken up during the convention, and it is expected these discussions will have an important bearing on the future manufacture of materials that have been scarce and high-priced ever since the curtailment of American commerce with Germany and other European countries. In order to fill the demands for chemicals hundreds of factories have sprung up in various parts of the country, and while doing a large business, it is pointed out by experts that there is a lack of preparation to meet new conditions which are bound to follow at the close of the war.

Will Add to Plant.

At an estimated cost of $50,000 the Nitrogenus Chemical Co., Philadelphia, Pa., will erect a two-story concrete and brick addition to its factory at 37th and Tasker Sts.

Capt. Schlotz Now on Active Duty.

Active duty as captain in the Engineer Officers' Reserve will be taken up by Herman F. Schlotz, assistant chief engineer of the Newport Hydro Carbon Co. and the Newport Chemical Works, Inc., at Carrollville, Wis.

WANTED—Chemist; female, analytical and research. Apply during business hours, or phone Ossining 1057 for an interview. Ossining Chemical Works, Ossining, N. Y.

WANTED—Organic Chemist, of high caliber; must have had experience in research, plant design and plant operation, a man of character and ambition required, who can qualify for responsible position in growing organization within thirty miles of New York City. Initial salary up to five thousand, depending on qualifications. State nationality and necessary details, which will be held in strict confidence. Box J. C., c/o Chemical Engineer.

CHEMIST for position as factory manager; must have thorough training in chemical engineering; draft exempt; best of references required; good salary with excellent chances for advancement. Apply Mangano Manufacturing Co., 17 Seminary Ave., Rahway, N. J.

Glass Cloth—Glass Wool
and everything in the line of spun glass.

The glass cloth made entirely of glass, or with wire or silk warp, which we are now manufacturing, can be used for all insulation purposes; storage batteries, etc., etc.; where fireproof articles are required, such as curtains, draperies, hangings for hotels, theatres and public places; for diffusing light in moving picture studios, etc., etc.; for filtering and straining acids, etc.

Inquire at once about this new product and its application to your work.

L. REUSCHE & CO. 12 Barclay Street
NEW YORK CITY

CHEMICAL MAGAZINES
BACK COPIES OF DOMESTIC AND FOREIGN PERIODICALS FOR SALE. WE BUY SETS, VOLUMES, AND NUMBERS.
B. LOGIN and SON
152 EAST 23rd STREET, NEW YORK CITY

DESIGN OR CHEMICAL BUILDINGS
AND COMPLETE EQUIPMENTS
MILL ENGINEER
Frank Sutton
80 BROADWAY, N. Y. C.
Established 1897 Tel. Rector 960

CHEMICALS
COLORS
MINERALS

For the following Trades:

RUBBER
PAINT
TEXTILE
POTTERY
OIL CLOTH
PAPER
PRINTING INK
LEATHER

KATZENBACH & BULLOCK CO.
New York Trenton Chicago
Boston San Francisco

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

There is one army more powerful than all the cannon on earth! It is behind the counters of the retail stores of this country.

Are you in command of part of it, you owner, manager or director of a retail business? You certainly are and you must launch it against the Powers of Evil now intent upon the destruction of everything worth your while as a business man.

SELL WAR SAVINGS STAMPS

Money will win this war and nothing else will. Valor without equipment is of no avail. Strategy without strength is of no avail. Money loaned our Government will assure them all for our armies—ships, guns, munitions, food, clothing, medicine, hospitals.

Give the order. Your salespeople will do the rest. They are fighters every one. They couldn't be soldiers in the greatest army in the world if they were not—the army of retail salespeople.

W.S.S.
WAR SAVINGS STAMPS
ISSUED BY THE
UNITED STATES
GOVERNMENT

PIONEER DIVISION
National War Savings Committee
51 Chambers Street, New York

Space donated by
The Publisher

Gas

(Concluded from page 342)

The Detroit "Combination" Gas Machine is a very simple machine, comprising an air blower (either in the weight or water driven type), an automatic mixing regulator which is usually located in the basement of the building, and a carburetor or generator which also serves as a storage tank, and is usually located about 30 feet from the building and buried underground.

This plant uses gasoline as fuel. By observing the illustration of the machine the reader will notice the air blower, which is either weight driven or water driven, takes air from outside and forces it through the carburetor or generator where it passes over the surface of the gasoline in the various cells, two, three or more, depending upon capacity of machine—the gasoline exposed to the air vaporizes in the form of gas and is returned to the combination mixing regulator, where it is diluted with air and delivered to the burners in a fixed quality.

The weight and water driven machine differs only in respect to air blower. The weight type requires an occasional winding, the water driven requires no attention at all—it's automatic.

The company advises us that these gas plants passed the experimental stage long ago, that they have been making these machines for the past 50 years, and have over 30,000 in daily use.

Any of our readers who are interested in investigating these gas machines should communicate direct with the Detroit Heating & Lighting Co., Detroit, who will be glad to send a general catalog describing the plants in detail. This is a very elaborate catalog. It is not only a complete treatise on the manufacture of cold-process gasoline-gas, but it gives names of users of these plants in practically all parts of the country, thus enabling intending purchasers to see plants in operation.

Abraham L. Konwiser Resigns.

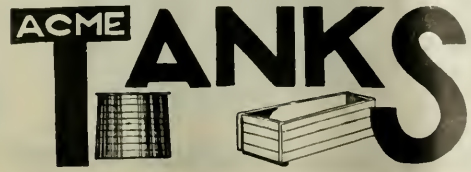
Following the resignation of Mr. Abraham L. Konwiser as supervisor of the analytical laboratory of the Metal and Thermit Corporation's plant at Chrome, N. J., Mr. Alexander Orschefsky has been appointed to take charge.

COTTON DUCK
AND
FILTER CLOTHS
COTTON FILTER CLOTHS
WOOL FILTER CLOTHS
and
FILTER PRESS SACKS
for
CHEMICAL and INDUSTRIAL PURPOSES
W. W. STANLEY
50 Church Street, New York City

Hugo Mock *Asher Blum*
Mock & Blum
PATENTS AND TRADE MARKS
CHEMICAL PATENTS A SPECIALTY
220 BROADWAY
NEW YORK CITY

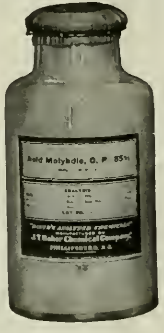
The Reed Laboratories
RESEARCH AND ANALYTICAL
SPECIALIZING IN LEATHER
TANNING AND DYEING MATERIAL
227 Fulton Street, New York, N. Y.

C. L. PARKER
Chemical Patents
TRADE-MARKS
UNFAIR COMPETITION
McGill Building, Washington, D. C.



ANY SIZE OR SPECIFICATION
Three factories, situated in the East, Middle West and Pacific Coast, enable us to give you special service in the manufacture of tanks.
We have on hand reserve supplies of air-dried woods suited for the different chemical requirements, making prompt shipments possible.
Our many years' experience in handling tanks to standard and special specifications should be of value to you. Your specifications will have our immediate and careful attention.
ACME TANK COMPANY
37 Cortland Street, New York

On Your Next Chemical Order—



SPECIFY

"Baker's Analyzed"

Chemicals and Acids

After a trial you will specify them on ALL your orders, because you will find them dependable reagents of the highest quality and uniformity.

An Accurate Analysis Appears on the Label of Each Bottle

Catalog on Request

J. T. BAKER CHEMICAL CO.

PHILLIPSBURG, N. J.

ANALYTICAL AND CONSULTING CHEMIST
MATERIALS ANALYZED—RESEARCH WORK.
FACTORY PROCESSES INVESTIGATED.
FRED'K J. AUSTIN, 119 Nassau St., N. Y. C.

American Aniline Products Acquires Plant.

To aid in carrying out a Government contract for aniline colors, principally khaki and navy blue, American Aniline Products, Inc., have acquired the plant of the United Pierce Dye Works, Nyack, N. Y.

Robax Chemical Co.

The Robax Chemical Co., Dover, Del., has been incorporated with a capital of $100,000 to manufacture chemicals. The incorporators are: Cornelius A. Cole, Hackensack, N. J.; Arthur R. Oakley, Pearl River, N. Y., and Paul E. Britisch, Brooklyn, N. Y.

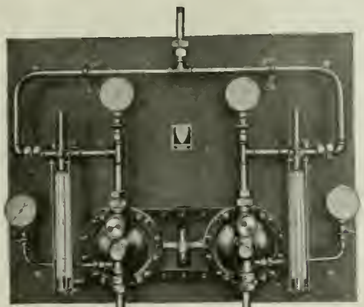
Will Make Abrasive Materials.

With a capital of $50,000 the Hamilton Abrasive Co., Westfield, Mass., has been incorporated under the laws of that state to manufacture abrasive materials. The incorporators are F. D. Hamilton, Louis M. Fuller and H. B. Putnam, Westfield.

Harvey Chemical Co.

With a capital of $50,000 the Harvey Chemical Co. has been incorporated at Hoboken, N. J., to engage in the manufacture of chemicals and allied products by Jacob J. Harvey, East Orange, N. J.; O. C. Harvey, Orange, N. J., and Harry B. Harvey, Newark, N. J.

The Control of Gases



We are specialists in the control, measurement, application and proportioning of gases. The cut above shows one type of equipment developed to combine in predetermined proportion two gases of totally different properties.

W & T EQUIPMENT
For Gas Control

is constructed with the same care and attention to minute detail that has distinguished "W & T" Chlorine Control Apparatus for Water and Sewage Purification.

Our Engineering Staff is prepared for Consultation on problems of Gas Control.

Wallace & Tiernan Co., Inc.
137 Centre Street
New York City

Gas for—
laboratory and industrial uses
—automatically made
by the
Detroit Combination Gas Machine
Descriptive catalogue and names of users in your vicinity sent on request.
Detroit Heating & Lighting Co.
616 Wight Street, Detroit, Mich.
Established 1868

"Detroit"
Laboratory Burner

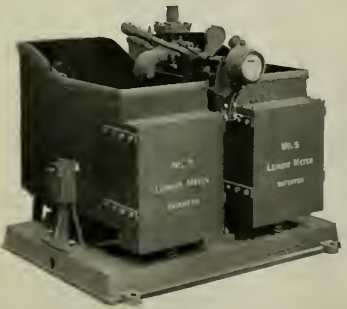
McCormack & Company
Chemists and Chemical
ENGINEERS

Analytical and Consulting Chemists

We enjoy making the unusual chemical analyses such as most chemists do not like to bother with.

We have at our disposal the best equipped laboratories in this country for the study of chemical manufacturing processes and problems.

OFFICE and LABORATORIES
33rd and Armour Avenue
CHICAGO Phone Douglas 390



"MORE THAN A METER"
The Improved Leinert Automatic Liquid Gravity Scales
(PATENTED)

A Simple-Positive Mechanical Balance for Recording by Weight. Recommended for WATER—JUICES—BRINE—CAUSTIC SOLUTIONS and LIQUIDS of all descriptions.

Not Affected by Temperature Changes or Variations in Specific Gravity. Special Scales to Meet Your Requirements. WRITE US YOUR SERVICE CONDITIONS.

JOHN SIMMONS COMPANY
107-111 Centre Street :: New York City

Chemically Pure

LABORATORY REAGENTS

Chemically Pure

ACIDS

Hydrochloric Acid, sp. gr. 1.19
Sulphuric Acid, sp. gr. 1.84
Nitric Acid, sp. gr. 1.42
Acetic Acid, 99.5%

Ammonia Water

sp. gr. 0.90

WE manufacture and carry in stock a full line of Chemically Pure analytical reagents. These reagents do not require preliminary testing, and the results obtained by their use are accurate.

Our Products will be furnished by the leading Supply Houses, if B. & A. Chemicals are specified on orders.

LIST FURNISHED ON REQUEST

The
Baker & Adamson Chemical Company

EASTON, PENNA.

C.P.N
CHEMICAL CO.
Covers the Country
"We Serve and Save"

EXCLUSIVE SALES AGENTS FOR

NEVIN CHEMICAL CO.

St. Louis, Mo.

MANUFACTURERS OF

Barium Binoxide
Barium Oxide
Barium Sulphide
Barium Nitrate
Barium Carbonate
Barium Chloride
Barium Sulphate, Dry and Pulp
Sodium Sulphide 60/62
Sodium Nitrite 99%
Sodium Nitrate Ref.

C P N CHEMICAL CO., Inc.

Department O

Industrial Chemicals

80 Reade St. New York
227 W. Huron St. Chicago
Chemical Bldg. St. Louis, Mo.

OUR GLASS BLOWING SHOP

is up to date and equipped for blowing, grinding, engraving and experimental work.

BEFORE PLACING YOUR NEXT ORDER FOR

CHEMICAL APPARATUS

GLASSWARE
THERMOMETERS
HYDROMETERS

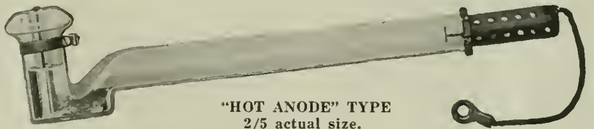
LET US GIVE YOU OUR PRICES

We are also Manufacturers of Metal Apparatus and Instruments. Write us at once.

SCIENTIFIC UTILITIES CO., INC.

84 East 10th St. Phone Stuyvesant 5439 N. Y. C.

For
RESEARCH CHEMISTS—
A Source of



"HOT ANODE" TYPE
2/5 actual size.

ULTRA VIOLET LIGHT

WHICH IS SUPERIOR TO ANY SIMILAR SOURCE

THE FACTS

about R. U. V. ultra violet ray lamps

The type illustrated above yields 2½ times the usual ultra violet ray component.
It operates on 220 volts D. C.
It is especially designed for laboratory use.
It employs no mercury vapor chamber at the anode end.
Its wave lengths have been measured as low as .18 u., which means *greater activity.*
Its frame is composed entirely of *new* and exceptionally clear quartz, thereby eliminating the loss of efficiency frequently resulting from reworked quartz.
It constitutes the final answer in all cases where experiments with ultra violet light have *failed* because the *source of rays was insufficient.*

WE WILL GLADLY FURNISH FURTHER DETAILS

THE **R. U. V. Co.** Inc.

165 Broadway, New York City Telephone "Rector" 6230

GLANDER & CO., Inc.

115 Broadway
New York City

Own and Offer

DRYERS

1—Direct Heat Rotary Dryer, 5'6"x40' complete with mechanical stoker.
1—Direct Heat Rotary Dryer, 5'6"x40' complete.
1—Direct Heat Rotary Dryer 3'x30' complete with stack.
1—Direct Heat Rotary Dryer 3'x18' complete.
1—Direct Heat Rotary Dryer, 3'x15' portable and self contained with oil tank, burner and stack complete.
1—Direct Heat Rotary Dryer 20"x9' complete.
1—Ruggles-Coles B2 Double Shell, Indirect Heat, Rotary Dryer 4'x21'.
1—Louisville Rotary Steam Heated Dryer 5'x20' complete.
1—Louisville Rotary Steam Heated Dryer 6'x25' complete.
1—Ord Standard 72" Fertilizer Cooker or Dryer with steam jacket and stirrer.

KILNS

1—Rotary 6'x60' complete with stack.
1—Rotary 5'x48' complete with lining.
1—Rotary 5½'x50' complete with lining.

MILLS

1—Tube Mill 4'x22' complete with silex lining, pebbles and automatic feeder.
1—Tube Mill 4'x10' complete with silex lining, pebbles and automatic feeder.
1—6'x22" Hardinge Conical Ball Mill, with lining, pebbles and automatic feed.
1—6'x9' Tube Mill, with lining, pebbles and automatic feed.
1—28" Schultz-O'Neill Pulverizer with dust collector and piping.

PRESSES

3—500 Ton Hydraulic Garbage Presses.
1—Hydraulic Scrap Press, new, 24" ram x 30" movement, with iron basket and pump.

EVAPORATORS

1—Double Effect Kestner Evaporator with 14 1½"x22'0" brass tubes in each effect.
1—Double Effect Evaporator with 100 1¼"x7' copper tubes in each effect. Horizontal type.
1—Double Effect Chrytalizer with stirrers, coils, and salt filters.

FILTER PRESSES

1—Sweetland Filter Press, 24" diameter, 29 plates.

TANKS, STILLS and KETTLES

1—Copper Six Section Still 3'x26' with coil condenser and copper dephlamator.
1—Reflux Condenser 3' diameter x 22" deep.
2—Jacketed, Agitated Open Top Kettles, 4'6"x7'x5/16" steel.
2—Cone Bottom Tanks or Digestors 6'x10'6"x½", manhole in cover and drop door at bottom.
1—Flat Bottom Tank or Digestor 4'x7x⅜", door in top. Grate and cleaning door near bottom.
1—Round Bottom, Open Top Cast Iron Kettle 72"x36"x½".
2—Duriron Cauldrons, 38" diameter x 22" deep.
6—Round Closed Copper Tanks, 300 gal., 500 gal., and 950 gal.

TANKS

1—Square Tank 12' long x 8' wide x 7' deep x 5/16"—5,000 gal. cap.
14—Square Tanks 12' long x 10' wide x 8' deep x 5/16"—7,200 gal. cap.
3—Square Tanks 10' long x 10' wide x 6' deep x 5/16"—4,500 gal. cap.
2—Square Tanks 25' long x 6' wide x 6' deep x 5/16"—6,750 gal. cap.
10—Square Tanks 17'6" long, x 10' wide x 5'6" deep x 5/16"—7,200 gal. cap.
3—Square Tanks 10' long x 9' wide x 6' deep x 5/16"—4,000 gal. cap.
1—Square Tank 15' long x 8'6" wide x 7'6" deep x 5/16"—7,200 gal. cap.
1—Square Tank 21'6" long x 7'6" wide x 7'6" deep x 5/16"—9,000 gal. cap.
2—Square Tanks 10' long x 10' wide x 7' deep x 5/16"—5,250 gal. cap.
3—Square Tanks 12' long x 12' wide x 8' deep x 5/16"—8,640 gal. cap.
4—Square Tanks 12' long x 12' wide x 6'4" deep x 5/16"—6,830 gal. cap.
1—Square Tank 10' long x 8' wide x 6'3" deep x 5/16"—3,750 gal. cap.
1—Square Tank 45' long x 7' wide x 7' deep x 5/16"—16,500 gal. cap.
1—Cylindrical Closed Tank, 44' diam. x 32' high—364,000 gal. cap.

Bottom—⅜" steel; first course, 7/16" steel; second and third courses, ⅜" steel; fourth, fifth and sixth courses, 5/16" steel. Top—No. 10 gauge steel.

Tanks are in first-class condition. Tanks are heavily reinforced with angle iron and tierods. Will quote attractive prices f. o. b. cars or barge Brooklyn, N. Y.

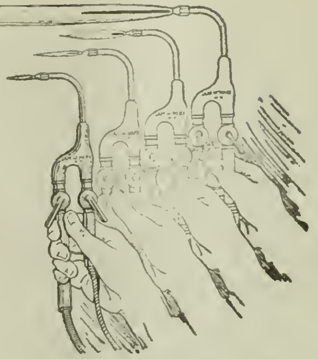
1—Closed Tank 4'2"x7'x5/16" with stuffing boxes in ends for shaft.
1—Open Steel Tank 21'6"x15', ½" and ⅝" stock.
1—Open Steel Tank 5'x6', ¼" steel.
1—Closed Steel Tank 9'6"x10', ¼" steel, manhole in cover.
2—Open Tanks 8'x8'x6'.

MISCELLANEOUS

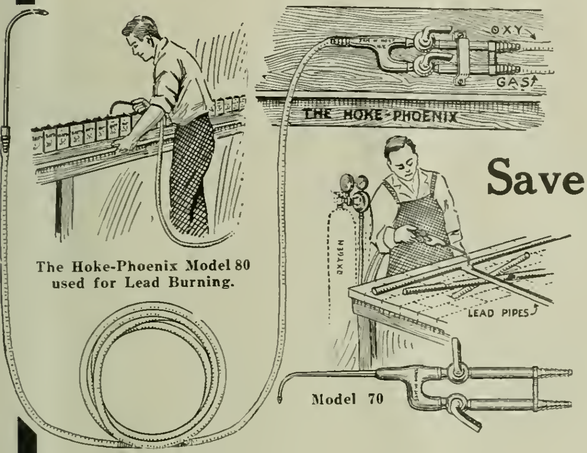
1—Steel Cylinder 78"x108'x¾'. Good for 200 lbs. pr. Doors at each end. Track and car inside.
1—Complete Cotton Seed Oil Plant.
1—Two Stage Clayton, Steam Driven Air Compressor, 7"x10"x8"
1—Fertilizer Screen, 1" mesh, 5'x14'6" with shaft 5"x19', with bearings, chain and sprocket for driving.

Fuller description given upon request.
We are interested in the purchase of chemical apparatus.

Every Shop and Laboratory Needs a Hoke-Phoenix



Various Flames of the Hoke-Phoenix Model 70.



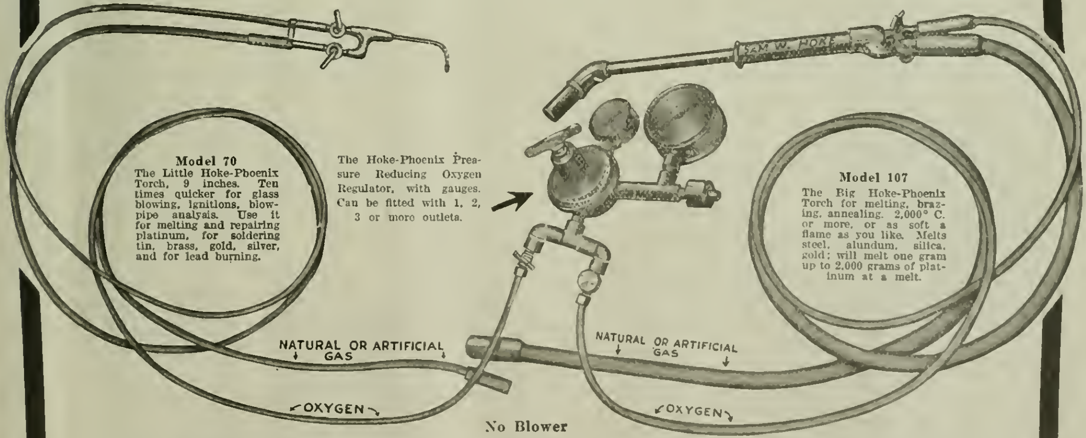
The Hoke-Phoenix Model 80 used for Lead Burning.

Model 70

Save Time

By using the Hoke-Phoenix Torches **whenever you need heat.** A sharp needle-like flame, hot enough to melt platinum or fuse silica, or a wide soft slow flame for gentle ignition.

For delicate or coarse glass-blowing; for every kind of fusion; for heating solutions QUICKLY. It does ordinary blowpipe or blastlamp work in a fraction of the time. Oxidizing or reducing flame; no blower, less noise; instant adjustment. Save time!



Model 70
The Little Hoke-Phoenix Torch, 9 inches. Ten times quicker for glass blowing, ignitions, blowpipe analysis. Use it for melting and repairing platinum, for soldering tin, brass, gold, silver, and for lead burning.

The Hoke-Phoenix Pressure Reducing Oxygen Regulator, with gauges. Can be fitted with 1, 2, 3 or more outlets.

Model 107
The Big Hoke-Phoenix Torch for melting, brazing, annealing. 2,000° C. or more, or as soft a flame as you like. Melts steel, alundum, silica, gold; will melt one gram up to 2,000 grams of platinum at a melt.

No Blower

Chemists—Metallurgists—Dentists—Jewelers—Shop Mechanicians—everybody that uses a flame—Use a Hoke-Phoenix Torch. They use ordinary gas at ordinary pressure, in connection with oxygen. They do everything that a Bunsen or blast lamp does in a fraction of the time; they do almost everything that the oxy-acetylene flame does, more cheaply and more safely.

ASK FOR INFORMATION ABOUT YOUR KIND OF WORK

Sam W. Hoke, Mgr.

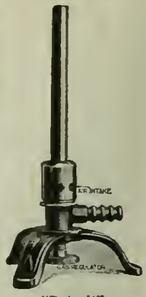
Jewelers Technical Advice Co.
12-16 John St., New York

OXYGEN

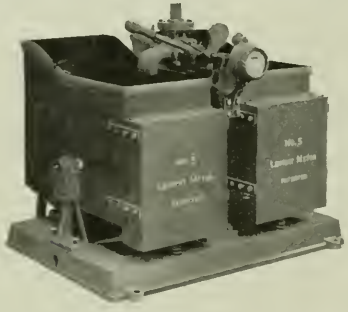
TO FILL PRESENT NEEDS WE ARE SUPPLYING OXYGEN IN LOW PRESSURE TANKS TO ACCOMMODATE THE TRADE WHO DO NOT REQUIRE LARGE QUANTITIES OF GAS IN ONE SHIPMENT.

BESELER OXYGEN CO.
131-133 E. 23rd St., N. Y. C.

Gas for—
laboratory and industrial uses
—automatically made
by the
Detroit Combination Gas Machine
Descriptive catalogue and names of users in your vicinity sent on request.
Detroit Heating & Lighting Co.
616 Wight Street, Detroit, Mich.
Established 1868



"Detroit"
Laboratory Burner



"MORE THAN A METER"

The Improved Leinert Automatic Liquid Gravity Scales

(PATENTED)

A Simple-Positive Mechanical Balance for Recording by Weight. Recommended for WATER—JUICES—BRINE—CAUSTIC SOLUTIONS and LIQUIDS of all descriptions.

Not Affected by Temperature Changes or Variations in Specific Gravity. Special Scales to Meet Your Requirements. WRITE US YOUR SERVICE CONDITIONS.

JOHN SIMMONS COMPANY
107-111 Centre Street :: New York City

H. A. METZ & CO., Inc.

122 HUDSON STREET, NEW YORK

BOSTON
PROVIDENCE
PHILADELPHIA
CHICAGO
SAN FRANCISCO
CHARLOTTE
ATLANTA

PRODUCTS:

Dyestuffs, Colors, Intermediates, Sizing and Finishing Materials

Dyestuffs, Colors, Sizing and Finishing Materials *Produced by* Consolidated Color and Chemical Co. Newark, N. J.

Dyestuffs and Intermediates *Produced by* Central Dyestuff and Chemical Co. Newark, N. J.

THE METALLURGICAL CHEMICALS CORPORATION

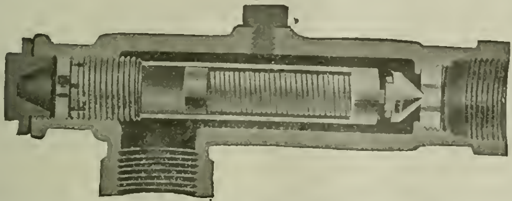
2 East 24th Street, New York

Producers of

Molybdic Acid 88%

Ammonium Persulphate

WRITE FOR SAMPLES AND QUOTATIONS



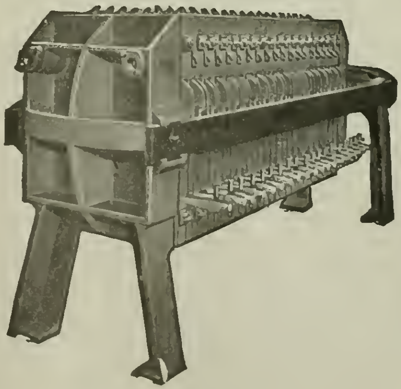
STEAM TRAP SARCO

Judged by its guaranteed capacity it is the most compact and least expensive steam trap made. Good for any pressure up to 200 lb.

The efficiency of the SARCO is in no wise impaired by its low price. You can bank upon its staying tight in service.

Be satisfied before you buy—take advantage of our 30 days free trial offer. Write for Bulletin and details.

SARCO COMPANY, Inc.
Woolworth Bldg., New York City
Ellicott Square, Buffalo; New Telegraph Bldg., Detroit; Drexel Bldg., Philadelphia; Monadnock Block, Chicago; Williamson Bldg., Cleveland, O., and representatives in all principal cities.
Canada: Peacock Brothers, Montreal.



15,000 "Johnson" Filter Presses

NOW IN USE

All Types, All Sizes
Made of
Iron, Bronze, Lead, Aluminum,
Tin and Wood,
also
Belt, Steam and Electrically
Driven
Filter Press Pumps
and
Turbine Mixers

The "Johnson" Diaphragm Pump

Backed by Forty Years' Experience

John Johnson Company
37th Street and Second Avenue, Brooklyn, N. Y.

Largest American Producers of

Army Khaki
for Cotton and Wool

Blues
for Navy Cloth

Diphenylamine
Dimethylaniline
Aniline Oil
Dinitrophenol
Monochlorbenzol
for Explosives

National Aniline & Chemical Company
Incorporated
Main Sales Office: 21 Burling Slip, New York

BRANCHES:

Boston
Charlotte
Chicago
Cincinnati
Hartford
Kansas City
Milwaukee
Minneapolis
Philadelphia

Back up the Boys in France—Buy W. S. S. regularly

THE CHEMICAL ENGINEER

Copyright, 1918, by McCready Publishing Company

VOL XXVI. SEPTEMBER, 1918 No. 10

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

LAURANCE T. CLARK,
Editor.
CHARLES B. DAVIS, F. C. S., Consulting Editor
H. C. DAYCH, Business Manager

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

CONTENTS, SEPTEMBER, 1918

Pay Us a Visit.

To all our readers and to visitors at the Chemical Show, the staff of The Chemical Engineer extends a cordial invitation to visit us at Booth 465, located at the extreme rear of the third floor (take elevator), close to the entrance of the Motion Picture and Conference Hall. Here a reception booth will be maintained, and all are invited to make this their headquarters with the full assurance of a hearty welcome, coupled with what services or information about the show we are able to furnish.

"Magic Four" 367
Facts About the Chemical Show This Year 367
Program and Time Schedule; Fourth National Exposition of Chemical Industries 368
Don't Delay Your Census Return 370
Problems of Filtration Solved by Glass Cloth 371
New Blowpipes for the Laboratory and Shop 371
C. E. Drayer Appointed Secretary of A. A. E. 372
The Recovery of Light Oils and Refining of Toluol .. 373
Organic Symbols; A System of Chemical Shorthand .. 377
Ingo W. D. Hackh.
Chemical Warfare Service; Its History and Personnel 379
Ultra Violet Light: Its Application in Chemical Arts. Part XVII 385
Carleton Ellis and A. A. Wells.
Coal-Tar Chemistry Section 387
  Tanning Materials from Phenol 387
  Manufacture of Derivatives of Toluene, Chlorinated in the Side-Chain 387
  A Method for Condensing Salicylic Acid Vapor .. 388
Exhibitors at the Fourth National Exposition of Chemical Industries 389
Foreign Trade Opportunities 393
New Publications 394
  "Copper" 394
  "Thermal Expansion of Alpha and of Beta Brass" 394
  "Effect of the Size of Grog in Fire-Clay Bodies" .. 395

"Magic 4"

Before the next issue of this journal is in the hands of its readers it will be too late for you to change your decision regarding the amount of your investment in the safest securities obtainable anywhere in the world today. The Fourth Liberty Loan and the Fourth National Exposition of Chemical Industries are at hand. Both eclipse their predecessors in magnitude and importance, and if there yet remains any virtue in the traditional "Magic 4," the results of both should be most happy.

Already the hope has been expressed that the Fourth Liberty Loan may prove a Victory Loan. Predictions are rife, but these may safely be left in the hands of the military experts who write for the daily papers. There need be no speculation to cloud the issue in the minds of all the rest of us. The main object is to get behind this loan and push it with all the strength of a pocketbook which, but for the able protection of the Government which now asks *your* help, would have been practically non-existent months ago.

And should this indeed prove a Victory Loan, the opportunity of a lifetime to show that you appreciate the sacrifices being made hourly for you, will be gone forever. Our soldiers and sailors eagerly snap up Liberty Bonds to the limit of their financial resources, and during the last loan an East Indian potentate sent a fortune to Washington to be exchanged for Liberty Bonds, purely as a safe investment.

This is no time for quibbling. Uncle Sam needs money to protect *you*. You must do your part.

Facts About the Chemical Show This Year

It is estimated that some 25,000 chemists from all parts of this country, Canada, South America, and from a number of our Allied countries in Europe, are in New York to attend the Fourth National Exposition of Chemical Industries this year and the conventions being held in conjunction with it. It is at once the largest and most important exhibition of its kind ever held, and many new products are being shown for the first time.

More than 350 exhibits, representing every field of industrial chemistry and chemical manufacture are on display and are being demonstrated, while the pres-

(*See second page following.*)

PROGRAM AND TIME SCHEDULE

The Sign of ◎ Achievement

Fourth National Exposition of Chemical Industries

Grand Central Palace, New York, September 23-28

MONDAY, SEPTEMEBR 23.

Evening—Opening Addresses: Dr. C. H. Herty, Chairman Exposition Advisory Committtee. Dr. Wm. H. Nichols, President American Chemical Society. Mr. F. J. Tone, President American Electrochemical Society. Dr. G. W. Thompson, President American Intstitute of Chemical Engineers.

TUESDAY, SEPTEMBER 24.

Afternoon—Symposium on Acids and Chemical Engineering: A. Hough, "Chemical Engineering in Explosives; T. N. T., T. N. A., Picric Acid, Nitrobenzol." E. J. Franke, "Developments of Nitric Acid Manufacture."

Evening—Motion Pictures.

WEDNESDAY, SEPTEMBER 25.

Afternoon—Symposium on Potash: C. A. Higgins, "Recovery of Potash from Kelp." Linn Bradley, "Recovery of Potash from Iron Blast Furnaces and Cement Kilns." John W. Hornsey, "Potash from Desert Lakes and Alunite." H. W. Morse, "Potash from Searles Lake."

Evening—Motion Pictures: Alkali Industries: 1. Electrical Precipitation of Potash from Cement Dust. (Research Corporation.) 2. Colloid Chemistry.

THURSDAY, SEPTEMBER 26.

Afternoon—Symposium on Ceramics—Meeting of the American Ceramics Society: L. E. Barringer, "Manufacturer of Electrical Porcelain." (Illustrated.) A. V. Bleininger, "Recent Development in the Ceramic Industries." H. Ries, "American Clays." F. A. Whitaker, "Manufacture of Stoneware." (Illustrated.) J. B. Shaw, "Fuel Conservation." S. C. Linberger, "Carborundum Refractories."

Evening—Motion Pictures: Glass Making (Corning Glass Works). The Making of Cut Glass (Ford). Manufacture of Eletcrical Porcelain (General Electrical Company). The Making of Pottery (Ford).

FRIDAY, SEPTEMBER 27.

Afternoon—Symposium on Metal Industries: Leonard Waldo, "Development of Magnesium Industry." Alcan Hirsch, "Ferrocerium Pyrophoric Alloys." Theodore Swann, "Ferromanganese." Joseph W. Richards, "Ferro-Alloys of Silicon, Tungsten, Uranium, Vanadium, Molybdenum and Titanium."

Evening—Motion Pictures.

SATURDAY, SEPTEMBER 28.

Afternoon—Symposium on Industrial Organic Chemistry: S. P. Sadtler, "Industrial Organic Chemistry and Its Progress." C. A. Higgins, "Kelp as a Source of Organic Solvents." G. H. Tomlinson, "Wood Waste as a Source of Ethyl Alcohol."

Evening—Motion Pictures.

Among other films that will be shown each evening of the week are the following:

OIL INDUSTRIES.

The Spirit of the Flowers—Esential Perfume Oils.
The Story of a Cake of Soap.
Light from the Rocks—Natural Gas.
Lake Asphalt Industry (Barber Asphalt Paving Co.).
Asphalt Roofing Industry (Barber Asphalt Paving Co.).
Asphalt Coiloids (Barber Asphalt Paving Co.).

WATER POWER; ITS DEVELOPMENT AND USE.

Niagara Falls.
Power Transmission.
Power of Wealth—Hydraulic Development.
Canadian Shawinigan Falls Power Development and Its Surrounding Chemical Industries (Shawinigan Water & Power Co.).
Fixation of Atmospheric Nitrogen at Niagara Falls and Feeding the Soil with It (American Cyanamid Co.).

CARELESSNESS; THE DESTRUCTION OF LIFE, WEALTH AND RESOURCES.

Careless America (Firestone—Universal).
The Crime of Carelessness.
The Workman's Lesson.
Vaccines for Prevention of Disease.
Keep Your Business Going (General Fire Extinguisher Co.).

MISCELLANEOUS CHEMICAL INDUSTRIES.

Manufacture of Zinc Oxide (New Jersey Zinc Co.).
Manufacture of Genuine Wrought Iron Pipes (A. M. Byers Co.).
From Log to Lumber (Southern Pine Association).
Moving a Forest to France (Southern Pine Association).
The Wonderland of the Appalachians (Clinchfield Railway).
The Operation of a By-Product Coke Plant (H. Koppers Co.).

ence of men prominent in chemical and industrial plants, in colleges and industrial schools, in government and civilian work, who have been marshalled for the exhibition, gives ample evidence that it has fulfilled its aim, namely, to function as an educational event without parallel in its own particular field.

Next Year?

It is indeed fortunate for exhibitors and visitors that the plans of the Government to take over the Grand Central Palace for war work did not interfere with the date set for this eagerly-awaited show, for a certain amount of confusion is always bound to result from an eleventh hour change of location. However, this is the last exhibition of any kind to be held in the Palace until after the war is over. Judging, however, from the daily reports of the activities of an Army which the Kaiser declared didn't exist in a country which "wouldn't fight," it begins to look as though the doors would open on the *Fifth* National Exposition of Chemical Industries in the usual place.

Watch for the "Bull's Eye!"

One of the fundamental objects of the Chemical Exposition since its inauguration has been to call attention to chemical products manufactured for the first time in this country subsequent to the bursting of the storm which shut off Germany's exportations of many needful things. But until the present show it was not possible to tell at a glance just which products displayed belonged to these more recent triumphs of America's industrial chemists. Now, however, the management has evolved a method for displaying such products in a manner better calculated to focus the attention of casual visitor and chemist alike, and accordingly each will be adorned by a label upon which is printed a bull's eye. This label, however, will appear only on the products themselves and not upon new machinery. Visitors to the show should watch for this bull's eye, for each one constitutes an order of merit for an American chemist and records a "direct hit" upon the supposedly impregnable armor of Germany's chemical industries.

Watch for this label

on exhibits at the show.

A Record of Achievement.

In view of the present international situation regarding chemical industries in general and their rapid growth in the United States during the period of the European war in particular, the exposition has a message to deliver emphasizing the opportunity which is now being presented to the American manufacturer: Necessity has spurred on many chemists, and just how far they have succeeded may be judged by the exhibits at the exposition. The American chemist has come to the front and has shattered in four years the "line" of the German chemist, which had been building for more than forty years. In other words, the camouflaged "veil of mystery" of the German chemists has been lifted by the American chemists, whose discoveries or "secerts," as the Germans called them, are not locked in the brain of one man, but are given to others for the betterment of the industry. At the exposition this getting together of science and industry, with timely addresses and motion pictures, the exchange of ideas is certain to benefit all those who attend, and its influence in bettering and increasing the national production will be strongly felt.

The poster for this year's Exposition is the work of Rudolph Funk, of Brooklyn, N. Y., and was selected from others submitted by students at Cooper Union, New York City.

Wide in Scope.

While the exposition brings manufacturers of machinery, equipment, products, and supplies together with men who are using them, its chief purpose is to show the people of the country that the chemists of America have made rapid advances the past year—greater than ever before in this country's history. The convention brings to light some of the marvelous results of recent research, and many engineers and experts who hold important positions in the advance of the chemical industry are among the speakers.

The advisory committee of the exposition is composed of Charles H. Herty, chairman; Raymond F. Bacon, L. H. Baekeland, Ellwood Henrick, Henry B. Faber, Bernard C. Hesse, A. D. Little, W. H. Nichols, R. P. Perry, H. C. Parmelee, G. W. Thompson, F. J Tone, T. B. Wagner, and M. C. Whitaker. Charles F. Roth and F. W. Payne are the managers. Dr. Bacon, of this committee, is now head of the Chemical Warfare Section of the National Army and a member of General Pershing's staff.

Some sections of the South again are sending exhibits, and Canada is taking the opporuntiy of presenting the materials it has available for development by the chemist and financier. Technical and business men over the country should give heed to these exhibits, since they will show how they can meet the wartime need. A section for the Glass and Ceramic Industry, with which the American Ceramic Society is co-operating, has been added.

Papers covering practically every phase of chemistry and a discussion of steps that will need to be taken after the war, are being presented by leading experts in each branch. Pressing chemical problems concerning many of the chief articles of domestic and foreign commerce will be taken up during the convention, and it is expected these discussions will have an important bearing on the future manufacture of materials that have been scarce and high-priced ever since the curtailment of American commerce with Germany and other European countries.

Program.

A complete program and time schedule of the expositon, including the speakers and their subjects, and motion pictures to be presented, together with a list of the exhibitors, will be found on other pages of this issue. Instead of remaining open from 11 a. m. until 11 p. m., as was the custom last year, the doors of the present exposition do not open until midday and close promptly at 10.30 o'clock each night.

Don't Delay Your Census Return!

As Director of the newly-organized Chemical Warfare Service, Maj. Gen. William L. Sibert is assisting the War Department in gathering additional information regarding the chemists of this country. The following letter and the accompanying census blank, which all chemists are requested to fill out upon receipt and return promptly are self-explanatory:

WAR DEPARTMENT
CHEMICAL WARFARE SERVICE
WASHINGTON, D. C.

September 1, 1918.

To the Chemists of the United States:

This is a chemical war; therefore the War Department must have immediately available all possible information regarding chemical materials and chemical man power. Of these two essential elements chemical man power has so far received less attention. The census of American chemists made by the American Chemical Society in 1917 has been of great assistance to the War Department. Without it the present state of progress of the United States in chemical warfare would have been impossible of attainment.

However, during the same period conditions have undergone rapid and radical changes. The old census, excellent as it was, is no longer completely adequate. With the organization of the Chemical Warfare Service as an independent branch of the War Department, unifying all the elements of chemical warfare, it is obvious that the War Department must have its own set of records on a matter so vital to its own success. Moreover, these records must contain information which a short time ago was apparently of little importance. The new census must be made primarily from the viewpoint of the military status of chemists.

The importance of a prompt return of the census blank, properly filled out, by every chemist of the country cannot be overstated. American chemists are presented at this moment with one of the greatest opportunities to serve their country by the simple process of answering this questionnaire with all possible speed.

(Seal) (Signed) WILLIAM L. SIBERT,
Major General, U. S. A.,
Director of Chemical Warfare Service.

Questionnaire.

Date......................
Name ....
(Last) (First) (Middle)
Present address ....
Permenent address ....

I. GENERAL.

1. Born (a) Date.............. (b) Place.......... 2. Age........ 3. Place of birth (a) of father...... ...... (b) of mother .... 4. Are you an American citizen?........... 5. If naturalized, give date................ 6. Are you married?.......... 7. Is your wife living?.......... 8. How many people are dependent upon you (a) wholly?........... (b) partially?............

II. TRAINING.

9. Give the names of the schools, colleges, universities, graduate schools, or technical schools, which you have attended, with dates of attendance, courses pursued, and degrees granted.

....
Institutions Dates Courses pursued Degree
....
....

10. State any other training you have had..........
11. State fully the courses of study in which you have specialized ....
12. What foreign languages do you (a) speak....... .... (b) read?........... (c) write..........
13. Of what technical societies are you a member?
....

III. PRACTICAL EXPERIENCE.

14. In what foreign countries have you had experience and how much?.............................
15. How many years of continuous experience have you had? ....
(a) Industrial............. (b) Teaching...........
(c) Other ....
16. What experience have you had along executive and administrative lines?.........................
17. State in detail your duties in your various positions ....

From—To Employer Title Nature of work Salary (Statement optional and confidential)
....
....
....

18. Publications.

Title	Publisher	Date
....	....	....
....	....	....

19. State specifically the kind of work you do best ....

20. In the present emergency how and where, in your opinion, could you be of most service to your country ....
....

IV. SERVICE.

21. Do you desire to enter the service of the United States at once (a) in a civilian capacity?............
(b) In a military capacity?........................
Note. If you answer this question in the affirmtive, answer the rest of the questions in this section insofar as they apply to your case: Otherwise, skip to section V.

22. What rank (or salary, if you desire a civilian appointment) would you accept?..................

23. What has been your total military experience?
....

24. Are you registered in the draft?................

25. What is your Order Number?....................

26. What is your Serial Number?...................

27. Have you received the draft questionnaire?.....

28. How have you been classified?..................

29. Give names and addresses of three or four responsible persons (not relatives) or send letters of recommendation herewith.

Name	Address
....	....
....	....

V. MISCELLANEOUS.

30. State anything else, which will aid us, or which you want us to know, which is not covered by the questions on this folder. (Answer this question last.)
....

Please re-read this whole questionnaire and sign below.

Signature ....

Problems of Filtration Solved by Glass Cloth

A comparative novelty in the field of chemical engineering, but one which is expected to fill an important role in the continued advancement of our mastery of the many mechanical problems which confront the industrial chemist at every turn, is the application of glass cloth to processes involving filtration.

This material is a recent product of the experimental department of L. Reusche & Co., New York. It is the outgrowth of a discovery which makes possible the spinning of glass in endless lengths, instead of a maximum of about eighteen feet, as heretofore. The strands of spun glass were formerly woven in their original condition, which produced a somewhat rough surface, but subsequent experiments in braiding led to the production of a woven fabric in which the warp was braided and the "filler" unbraided. It found many applications, but the final achievement was marked by the manufacture of glass cloth composed entirely of braided strands.

Its use in filtration has not as yet been called to the attention of industrial chemists generally. Substituted for cloth or paper, its principal claim to distinction lies in the fact that it will outwear anything now in use. It does not deteriorate, as is the case with the two above-mentioned mediums, and it can be readily cleaned, which obviates the frequent replacing of cloths in filter presses.

Owing to its composition, it is capable of filtering all acids with the exception only of HFl., which attacks glass, and in tensile strength it meets all tests required of it under actual working conditions. It is produced in weaves of varying fineness and can be manufactured satisfactorily under a wide range of specifications for special uses. It has successfully withstood a pressure of 60 lbs. while employed in a filter press.

Chemical engineers who have inspected this product have in many cases divined uses for it in connection with their own work which are still unknown to the manufacturers, and have spoken enthusiastically of the results. As is usual with a new product of any kind, the full extent of its application in the chemical industries is not as yet determined, but already a number of technical men are experimenting with it, while additional tests of its application in various kinds of work are constantly being made in the laboratory of the producers.

New Blowpipes for the Laboratory and Shop.

A new method of securing high temperatures which has had a four-year practical demonstration in the metal trades, is now taking its place in the chemical industries. The method is based on the use of ordinary gas at ordinary pressure in connection with oxygen. The Hoke-Phoenix blowpipes and torches, made in a variety of styles and sizes, have been developed, and are being used for practically every purpose that requires heat quickly.

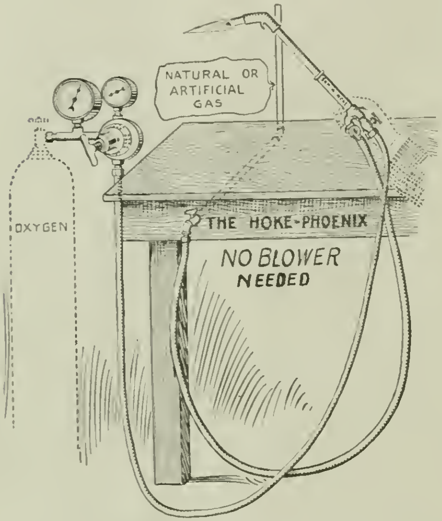
Originally designed for melting platinum, the Hoke-Phoenix blowpipes give a temperature of over 2000° C. (about 4000° F.). This melts silica, alundum, iridio-platinum, and most of the refractories on the market. But the flames are so readily adjusted that they can be used for lead burning, glass blowing, soft soldering, brazing, gentle ignitions, and so on. Either a soft, wide, slow flame, or a sharp needle-shaped flame, can be had by the adjustment of the needle valves or gas cocks with which each torch is provided.

Either an oxidizing or a reducing flame is obtained at will.

The special improvement offered by the Hoke-Phoenix is that it uses ordinary natural or artificial gas. This is not only much cheaper than acetylene, but vastly more convenient. Oxygen can be obtained almost anywhere. The Hoke-Phoenix will do almost everything that the oxy-acetylene will do, and certain things it will not do. But perhaps its greatest usefulness is as a time saver on work that can be performed with the slower air blast or Bunsen flame.

The large size Hoke-Phoenix blowpipes are used for such jobs as preheating, brazing big pieces, for melting platinum and gold, etc., for making up alloys, for annealing, tempering, and the like. Large quantities of solutions can be heated up quickly with them.

The smaller sizes will weld and solder the finest wire, including platinum wire, are most useful for glass blowing, repairing platinum and glass apparatus, for lead burning, and for blowpipe work of every kind. Many of the surgical instruments and brass buttons now being made for the Government are brazed or soldered with these small torches.



The Hoke-Phoenix torch outfit for melting metals.

The outfit comprises one or many torches, an oxygen regulator (pressure reducing valve) and the necessary tubing. The regulator serves to deliver the oxygens to the torches at exactly the right steady pressure, regardless of the pressure within the oxygen tank. Its gauges tell, respectively, how much oxygen is in the tank, and the pressure at which it is being delivered. In the few cases where ordinary gas cannot be obtained, tanks of hydrogen, acetylene, or compressed artificial gas, can be substituted.

One, two, or a dozen outlets can be connected to one regulator, so that any number of men can work at once, all from the same tank. Oxygen can be piped any distance.

It is claimed that the Hoke-Phoenix outfits save a great deal of time, are cheap and safe to operate, are easily handled and have a wide range of usefulness. They are made and sold by Sam W. Hoke, Mgr. Jewelers Technical Advice Co., 12 and 16 John street, New York.

C. E. Drayer Appointed Secretary of A. A. E.

The Board of Directors of the American Association of Engineers has announced to members and others the engagement of Mr. C. E. Drayer, of Cleveland, as National Secretary.

Mr. Drayer has been actively engaged in engineering society work of a local and national character for the past eight years. After graduating from college in Cleveland, Ohio, he served on western railroads until 1910, when he returned to Cleveland to become field engineer for the Nickel Plate Railroad on grade elimination work. He immediately joined the Cleveland Engineering Society and, as opportunity offered, took measures to advance the engineer in public esteem and to encourage him to train himself to be a leader in service to the community. After two years of marked success in the local society in Cleveland, he began to carry the message of progress to other societies and in time addressed most of the engineering organizations east of the Mississippi. In 1915 he became associated with Dr. F. H. Newell in forming the Committee on Engineering Cooperation, of which he is secretary. He organized and is secretary of the Ohio Association of Technical Societies. He is co-editor of "Engineering as a Career," a series of articles of advice to young men. For several years he was editorial correspondent for "Engineering News" and "Engineering News Record," where most of his articles on engineering society organizations have appeared. He served the Cleveland Engineering Society as its secretary for two years and was a member of its Executive Board when elected Secretary of the American Association of Engineers. He formulated the plan of combining the membership of the American Association of Engineers and Cleveland Engineering Society which promises to have a profound influence on engineering organization.

New Benzol Plant.

The Phillips Sheet & Pin Plate Co., Weirton, W. Va., expect to complete a plant for the production of benzol within the next year. The greater portion of their output will be furnished the U. S. Government for the manufacture of explosives.

Would Represent American Fi [illegible]

Announcement has been made by W. [illegible] & Co., London, chemical merchants and ma [illegible] chemists, that they are prepared to act as [illegible] buying agents and to represent American fir [illegible] in the heavy or fine chemical line.

Zaremba Offices Migrate.

The Zaremba Co., manufacturers of heavy [illegible] cal apparatus, have announced the removal of [illegible] offices to the Niagara Life Insurance Buil [illegible] Franklin and Mohawk streets, Buffalo, N. Y.

THE RECOVERY OF LIGHT OILS AND REFINING OF TOLUOL

Prepared by the U. S. Bureau of Standards*

Foreword.

This report has been prepared by the Bureau of Standards in response to the numerous inquiries for information regarding recovery of light oils and the refining of toluol. It has been submitted to, and revised in accordance with suggestions of, the committee organized under the chairmanship of Dr. E. R. Rosa of the Bureau of Standards at the request of the conference which met at the Bureau July 31, August 1 and 2. This committee consists of representatives of the Public Service Commissions, municipalities, manufacturers of gas, and makers of toluol recovery equipment. The assistance and co-operation of this committee are gratefully acknowledged by the Bureau.

Part I. The Technical Relation of the Gas Industry to the Military Needs of the Nation.

1. *High Explosives Manufactured from Gas By-Products.*—The importance of high explosives in the present war has been amply demonstrated. While nearly all kinds of explosives are used in some way, those which are most in favor for filling high explosive shells are manufactured from benzol and toluol, which substances have their most important commercial source in manufactured gas of one kind or another. The gas industry thus becomes directly and vitally connected with the conduct of the war and a survey of the demands which will be made upon it, and its preparedness in a technical way to meet these demands, is very important at the present time.

2. *City Gas Plants Must Supplement Coke-Oven Production.*—The constituents of illuminating and fuel gas which are important in the manufacture of explosives at the present time are benzol and toluol, especially the latter. The removal of these constituents from the gas which is a by-product of coke-oven plants has been practiced for some time. Plants manufacturing city gas, however, have not generally removed these substances from the gas since they contribute to its light and heat giving qualities and the substitution of other substances to maintain the gas quality up to prescribed standards has not usually been considered profitable. Even now, although several months have elapsed since the United States entered the war, comparatively few city plants are equipped to recover these materials, but the prospects are that in the near future they must do so if the requirements for high explosives are as great as is anticipated. Major Burns of the Ordnance Department at the conference held at the Bureau of Standards on August 1 stated that the army is dependent upon toluol for the manufacture of T.N.T. for shell filler. The amount of toluol needed depends upon the number of men engaged and how engaged. The present estimates are that toluol for shell filler will be needed in the coming year for our own army, for the Allies, and the navy at a rate considerably in excess of the present or anticipated supplies from works under construction. There is at the present time about four million pounds per month of T.N.T. nitrating capacity and sufficient toluol is not now available to utilize it; it is therefore now impossible to place more orders for T.N.T. primarily because more toluol is not available. It is probable that any and all explosives including the picrates will be necessary eventually.

3. *Manufacturing Processes in Use in the United States.*—The manufactured gas distributed in the United States is of three principal kinds: Coal gas, carburetted water gas, and oil gas.

The manufacture of water gas consists essentially of an intermittent process in which a bed of anthracite coal or coke is brought to a high temperature by an air blast and then steam under pressure is blown through the fuel, forming carbon monoxide, hydrogen and a small amount of carbon dioxide, by reaction with the carbon in the fuel. The resultant gas, called blue water gas, has a heating value of approximately 300 B. t. u. per cubic foot and almost no luminosity when burned in an open flame; it is conducted into a fire-brick lined chamber called the carburetter, which contains staggered rows of fire bricks, called checker brick, heated to incandescence during the blow period. Gas oil or fuel oil is sprayed into the carburetter while the gas is passing through, forming an oil gas which enriches the blue water gas to any desired heating value or candlepower. Another checker-brick-filled chamber, called the superheater, converts most of the oil gas vapors into permanent gases, which will not condense again upon cooling. During the formation of the oil gas certain portions of the hydrocarbons which compose the oil are changed in their composition to form benzol, toluol, and related hydrocarbons, called aromatic compounds. Considerable tar is formed at the same time. This is condensed, scrubbed, and washed out of the gas by various means, but usually at a temperature which permits most of the aromatics to go forward with the gas. The sulphur in the gas is removed by iron oxide purifiers and the gas is metered and leaves the plant at, or slightly above, atmospheric temperature.

---

*Published by permission of the Director, Bureau of Standards.

The manufacture of coal gas is essentially different from that of water gas. In this process certain classes of bituminous coals are distilled in fireclay or silica retorts or ovens and the resulting gases are condensed. scrubbed, washed and purified to remove water vapor, tar, ammonia, and sulphur. As in the water gas process, certain of the hydrocarbons given off by the coal are transformed by the heat of the retort to aromatic compounds. A small part of these aromatics are washed out of the gas by the wash water and tar, but the larger part remains in the gas; in fact, the cooling of the gas is usually so regulated that most of these substances will remain in the gas to increase its heating value and candlepower. Coal gas retorts take a variety of forms; among these are coke ovens. chamber ovens, horizontal D-shaped retorts, vertical retorts, inclined retorts, etc. Even those of a given class differ among themselves in details of construction. In most of them the distillation is an intermittent process, but some continuous methods are used. In all these processes the gas produced consists of the same constituents in somewhat different proportions. The form of apparatus used in a given case depends largely upon economic considerations or is governed by certain special qualities which are desired in one or more of the products produced. In all of these coal-gas processes, coke remains in the retort after distillation. In some of them. as. for example. in coke ovens. coke is the principal product; but in city gas plants, gas is the chief product. The operation is carried out in any case to give most satisfactory qualties to the principal product and at the same time obtain as high yields and good quality as possible of the secondary or by-products.

Mixed gas is usually understood to be a mixture of carburetted water gas and coal or coke-oven gas. It is supplied in many cities in the United States where the requirements permit of a mixed gas being supplied.

The manufacturing installation for mixed gas is practically two complete installations, one for coal gas and one for carburetted water gas, with their auxiliary scrubbing, condensing. purifying, and metering apparatus, entirely independent and separate. The manufactured mixed gas, however, is stored in common holders and delivered through a single distribution system.

The coal and water gas thus supplement each other. The uniform, but more cumbersome coal-gas production furnishes coke as fuel for the water-gas plant; this in turn takes care of the irregularities of the output and where necessary increases the quality of the gas production, especially where a high candlepower standard is in force.

The oil-gas process is at present confined chiefly to the Pacific Coast states, where comparatively cheap oil and expensive coal make the coal- and water-gas processes less feasible. In oil gas manufacture, oil alone is used as fuel for heating the checker bricks of the fixing chambers and oil is sprayed by steam into the chambers where in contact with the bricks, lampblack and permanent gases are formed. In this process also, aromatic compounds are included among the constituents of the gas.

4. *Average Content of Light Oils in Various Gases.*—The amount of benzol and toluol formed in any one of these processes is by no means definite. It depends upon the operating conditions and the quality of the raw materials (coal or oil). It would therefore be impossible to predict exactly what the yield in a given case would be, but an extensive inquiry into the operation of several typical plants has given the following approximate figures for the various processes. These

Data from Twelve Plants Investigated.

Approximate yield of crude light oils.

Horizontal-retort coal gas	3 gal. per short ton coal carbonized
Coke-oven gas	2.6 " " " " " "
Continuous vertical-retort coal gas*	1.8 " " " " " "
Carburetted water gas	10% of volume of gas oil used.

Composition of Crude Light Oils.

	Benzol.	Toluol.	Solvent naphtha, wash oil, naphthalene, etc.	Paraffins.
Horizontal-retort coal gas	38%	16%	46%	Less than 2%**
Coke-oven gas	55	14	31	Less than 2%**
Continuous vertical-retort coal gas*	15	15	58	12%
Carburetted water gas	42	25	33	Less than 2%**

Yield of Pure Products.

	Toluol.	Benzol.
Horizontal-retort coal gas	1.32 gal. per short ton coal carbonized	0.45 gal. per short ton coal carb.
Coke-oven gas	1.47	0.35 "
Continuous vertical-retort coal gas	0.27 "	0.26 "
Carburetted water gas***	0.15 gas. per 1,000 cu. ft. of gas ft. of	0.07 gal. per 1,000 cu. ft. of gas.

---

* Results from only one continuous vertical installation included here.

** This amount may be exceeded under some operating conditions, but paraffins can usually be kept down to this figure except in unusual conditions or with certain fuels.

*** The yield is variable according to amount of oil used in manufacturing the gas, being equivalent to about 2.0, 2.2% of the gas oil used in the plants investigated, but perhaps only about 1.6 in many cases.

figures are averages of the results obtained in the several plants; individual results may vary widely from them in a particular case.

No specific data are available for the amounts of toluol present in oil gas, though it is understood that the oil gas distributed on the Pacific Coast contains at least as much toluol as does coal gas.

Assuming that a ton of coal gives 10,000 cubic feet of gas and that 3.5 to 4 gallons of gas oil are used per 1,000 cubic feet of carburetted water gas, it is evident from the table that the amount of toluol obtainable per 1,000 cubic feet of rich water gas is considerably greater than that obtainable from coal or coke-oven gas.

5. *Prospective Toluol Sources.*—It does not seem likely that it will become practicable in the near future for plants having outputs less than 100 million cubic feet per year to recover light oils. A survey of plants of that size and larger indicates that there are about 112 plants having an aggregate annual gas output of about 135 billions cubic feet, of which about 97 billions are water gas, 25 billions coal gas, and 13 billions oil gas. What annual output of toluol could be expected from washing all this gas is problematical. It seems, however, that at least 0.05 gallon of toluol per 1,000 cubic feet of gas could be expected, which would give a prospective toluol recovery from all these companies of about 7,000,000 gallons per year. It seems likely that with an adjustment of standards the benzol production from the same amount of gas would be between three and four times as much as the toluol production, or approximately 18,000,000 gallons. These yields are by no means the maximum obtainable, since the production in some existing plants is higher than 0.05 gallon of toluol per 1,000 cubic feet. A few of the plants included in this estimate are already recovering part of their toluol and benzol, but by far the greater part of the available supplies are not yet recovered.

Part II. Principles Underlying Benzol and Toluol Recovery.

1. *Relation to Gas Plant Operating Conditions.*—Benzol, toluol, and the related hydrocarbons, which collectively will be designated as light oils, are present in city gas as condensible vapors and are associated with other hydrocarbons of the olefine and paraffin series which possess many physical properties similar to them. To separate some of these substances, especially the paraffins, from the light oil by commercial methods is well nigh impossible, and therefore it is important so to control the conditions of gas manufacture that as little of these substances will be present in the light soils as is possible. The presence of more than 2 per cent. of paraffin compounds in toluol is said to make it unfit for the manufacture of explosives. Only by careful attention to the temperatures and other operating conditions maintained in the gas making process and by the use of suitable raw materials can the gas manufacturer be certain that the toluol obtained from his light oils will be salable; for example, in the recovery of light oils from water gas not only the temperature but the rate of oil injection, spacing of checker bricks, etc., all affect results. Dirty checker bricks are said to be a very common source of high paraffin content in the toluol produced. The favorable conditions can only be determined by trial in each particular case.

For the successful operation of plants in which partial or total rectification of the light oils is carried out careful technical control seems to be a prime essential. In smaller plants where only light oil is recovered technical supervision should be available in starting the plant and for such a time afterwards as will enable the regular operators to become familiar with the fundamentals of operation and establish a routine. It might be feasible for several small plants within a certain district to retain the services of a technical man who would divide his time among them, and make the more elaborate tests which are occasionally required for successful operation.

2. *Removal of Light Oils from the Gas.*—To recover light oils from the gas, the method now almost universally employed is to bring the gas into contact with an oil which has a solvent action upon the light oils. Oil washing of gas is accomplished by a variety of apparatus. In any case to obtain complete absorption it is necessary that an adequate amount of oil at a sufficiently low temperature be brought into contact with the gas. The temperature of the wash oil should not exceed 30° C (86°F). The temperatures obtainable in practice will, of course, depend upon the facilities available for cooling the oil. It is desirable to have the oil a little warmer than the gas to prevent condensation of water from the gas into the oil which gives trouble in the further stages of recovery. The amount of wash oil circulated through the washers will depend upon the amount of light oil vapors present in the gas, the temperature of the oil, the amount of gas to be washed, and the saturation of the wash oil which it is feasible to obtain. About 10 gallons of wash oil per 1,000 cubic feet of gas washed, seems to be an average figure.

The oil now usually employed for this purpose in this country is a petroleum distillate called from its color, "straw oil"; some plants use a creosote oil obtained from the distillation of coal tar. The choice seems to depend largely upon which is available in a given case. The qualifications which a wash oil should possess seem to be substantially as follows:

A creosote oil upon distillation should yield not to exceed 5 per cent. up to 200°C and not less than 90 per cent. between 200°C and 300°C. The oil should not contain more than 7 per cent. naphthalene and should not show any marked increase in viscosity down to 4°C. The oil should be as fluid as possible under the working conditions and should have as small capacity for heat as possible.

The characteristics of a straw oil for this purpose, as obtained from some operators, are substantially as follows:

(1) Specific gravity not less than .860 at 15.5°C.

(2) Flash point in open cup tester not less than 135°C.

(3) Viscosity in Saybolt viscosimeter at 37.7°C not more than 70 seconds.

(4) The pour test shall not be over — 1.1°C.

(5) When 500cc of the oil are distilled with steam at atmospheric pressure, collecting 500cc of condensed water, not over 5cc of oil shall have distilled over.

(6) The oil remaining after the steam distillation shall be poured into a 500cc cylinder and shall show no permanent emulsion.

(7) The oil shall not lose more than 10 per cent. by volume in washing with 2½ times its volume of 100 per cent. sulphuric acid, when vigorously agitated with acid for 5 minutes and allowed to stand for 2 hours.

Some operators claim to have successfully used ordinary gas oil or water-gas tar. It is claimed by other operators, however, that when gas oil is used the paraffin and olefine compounds in it are likely to contaminate the light oil and that on account of emulsification this oil soon becomes unfit for use. Water-gas tar, it is said, soon becomes too thick for use and soon leads to serious naphthalene deposits in the distribution system. The advantages claimed for these materials are their general availability and lower cost, and the fact that most gas companies already have adequate storage facilities for these materials.

3. *Stripping Wash Oil.*—To separate the light oils from the wash oil in which they are dissolved, some form of still is employed; the difference in boiling points makes possible the separation. In large plants there are used continuous stills, in which steam comes in contact with the wash oil and boils off the light oils. The light oil vapors together with the uncondensed portion of the steam ascend upward through a series of chambers, which will be described more in detail later. In their ascent they come in contact with descending wash oil carrying light oils which they assist in freeing. The light oil vapors together with some steam, naphthalene, sulphur compounds, etc., pass away from the still and are condensed. Some of the wash oil is also carried along with the light oils, and has to be separated in the subsequent treatment. In small plants either continuous or intermittent stills may be used.

4. *Refining.*—To obtain from the light oils those constituents which are in most demand, a further separation by distillation and chemical treatment is necessary. The light oil is distilled in some form of still, usually equipped with a rectifying column and dephlegmator or planer which will be described in more detail later. The latter apparatus acts as a partial condenser in which part of the vapor is condensed and falling downward through the rectifying column meets the ascending vapors and washes from them a portion of the high boiling constituents. Only the light low-boiling constituents are able to pass the dephlegmator uncondensed. What vapors shall be allowed to pass on to the condensers depends upon the temperature maintained at the dephlegmator. This temperature is regulated according to the particular oil which it is desired to separate from the light oil mixture at any particular stage of the distillation. By the use of the dephlegmator and rectifying column it is possible to obtain much more definite separation of the benzol, toluol, and other aromatics than would otherwise be possible. In making the first distillation of the light oil, it is usual to collect the distillate in three successive portions or fractions, making the "cuts" at predetermined temperatures. The first fraction is collected in containing vessel or receiver until the temperature at the top of the still is 100°C. This fraction is called crude benzol, since benzol is its chief constituent. The flow of distillate is then diverted into another receiver and collected until a temperature of 120°C is reached. This fraction is termed crude toluol, from its chief component. The fraction collected above 120°C is called crude solvent naphtha from the use to which it is put, as a solvent of various materials. The boiling point of pure benzol and pure toluol are 80° and 111°C respectively. It will be noted that one of the changes of fractions or cuts is made midway between these boiling points while the boiling point of pure toluol is midway between the other cuts.

That the first separation is by no means complete is shown by the following analysis, which is typical of a crude toluol fraction:

Benzol	11.1%
Toluol	64.4
Solvent	8.9
Residue, etc	15.6
	100.0

The above procedure is not universal. Some operators collect the crude benzol and toluol together and subsequently separate them. Some of the impurities present in the crude fractions have boiling points so close to those of benzol and toluol that they cannot be separated from them by distillation. To remove a certain class of these compounds, called olefines, the fractions are washed successively with strong sulphuric acid, caustic soda and water. The olefines form a thick tarry mass which settles out by gravity upon standing and is drawn off. The fractions are then redistilled in stills with very high rectifying columns and fractions are finally obtained which boil within a single degree of the temperature which have been determined as the boiling points of pure benzol, toluol, etc.

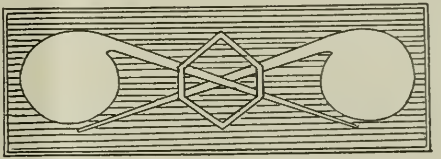
Some operators prefer to distil the toluol fraction from water gas light oils in a still without a rectifying column, previous to final distillation in a column still. The vapors from the still in this case pass directly through a condenser, coming out in liquid form.

(*Concluded on page 392*)

CHEMICAL WARFARE SERVICE

ITS HISTORY AND PERSONNEL

Watch for this insignia on the collars of uniformed men at the Chemical Show.



It designates a member of the newly-organized Chemical Warfare Service.

As far back as February, 1917, when it became thoroughly realized that in the event of war something must be done, and done quickly, if our soldiers were to enjoy adequate protection against the gas attacks of the Hun, and at the same time to be provided with the means for effective retaliation in kind, that a searching investigation of the myriad problems connected with the production and use of gas masks and poison gases was undertaken, after a conference with the War College, by a group of chemists and technicians working under the supervision of Director Van H. Manning of the U. S. Bureau of Mines.

Following the appointment later of the Committee on Gases by the National Research Council (April), and the subsequent appointment of the Advisory Board (November) headed by Dr. William H. Nichols, an experiment station was established in buildings of the American University in September of the same year. This station and work remained under the control of the Bureau of Mines.

The following month saw the creation of a Chemical Corps of the National Army, while coincidentally a body of chemical engineers who theretofore had been engaged in working on processes and plants for the manufacture of poison gases, was made a part of the Bureau of Ordnance of the War Department. It was this body of men which formed the foundation upon which the structure of the present Chemical Warfare Service was erected.

Subsequently, the experiment station at the American University was removed from the control of the Bureau of Mines and brought under the official wing of the War Department as a part of the then newly-organized Gas Defense Service. This was in keeping with the increasing determination of the Government to co-ordinate the efforts of our chemists. At the time of this transfer, a well-deserved tribute was vouchsafed the work of Dr. Manning and the staff of the Bureau of Mines by Secretary of War Baker in the following letter to the President:

War Department, Washington.
June 25, 1918.

My dear Mr. President:

In connection with the proposed transfer of the chemical section at American University from the Bureau of Mines to the newly constituted and consolidated Gas Service of the War Department, which you are considering, I am especially concerned to have you know how much the War Department appreciates the splendid services which have been rendered to the country and to the Army by the Department of the Interior, and especially by the Bureau of Mines under the direction of Dr. Manning. In the early days of preparation and organization, Dr. Manning's contact with scientific men throughout the country was indispensably valuable. He was able to summon from the universities and the technical laboratories of the country men of the highest quality and to inspire them with enthusiastic zeal in attacking new and difficult problems which had to be solved with the utmost speed. I do not see how the work could have been better done than he did it, and the present suggestion that the section now pass under the direction and control of the War Department grows out of the fact that the whole subject of gas warfare has assumed a fresh pressure and intensity, and the director of it must have the widest control so as to be able to use the resources at his command in the most effective way possible. The proposal does not involve the disruption of the fine group of scientific men Dr. Manning has brought together, but merely their transfer to General Sibert's direction.

Respectfully yours,
The President. (Signed) NEWTON D. BAKER.

This recognition of the part played by Dr. Manning and his workers in the development of the present organization was further amplified in a letter from President Wilson to the man whose foresight and initiative saved us so much valuable time:

White House, Washington.
26 June, 1918.

My dear Dr. Manning:

I have had before me for some days the question presented by the Secretary of War involving the transfer of the chemical section established by you at the American University from the Bureau of Mines to the newly organized Division of Gas Warfare in which the War Department is now concentrating all the various facilities for offensive and defensive gas operations. I am satisfied that a more efficient organization can be effected by having these various activities under one direction and control, and my hesitation about acting in the matter has grown only out of a reluctance to take away from the Bureau of Mines a piece of work which thus far it has so effectively performed. The Secretary of War has assured me of his own recognition of the splendid work you have been able to do, and I am taking the liberty of enclosing a letter which I have received from him, in order that you may see how fully the War Department recognizes the value of the services.

I am today signing the order directing the transfer. I want, however, to express to you my own appreciation of the fine and helpful piece of work which you have done, and to say that this sort of team work by the bureaus outside of the direct war-making agency, is one of the cheering and gratifying evidences of the way our official forces are inspired by the presence of a great national task.

Cordially yours,
(Signed) WOODROW WILSON.

Dr. Van H. Manning,
Chief, Bureau of Mines,
Department of the Interior.

EXECUTIVE ORDER.

It is hereby ordered that the Experiment Station at American University, Washington, D. C., which station has been established under the supervision of the Bureau of Mines, Interior Department, for the purpose of making gas investigations for the Army, under authority of appropriations made for the Ordnance and Medical Departments of the Army, together with the personnel thereof, be, and the same is hereby, placed under the control of the War Department for operation under the Director of Gas Service of the Army.

WOODROW WILSON.

The White House, 25 June, 1918.

Followed then the official organization of the Chemical Warfare Service, created through the issuance of General Order No. 62, U. S. War Department. The order follows:

GENERAL ORDERS, NO. 62.

CREATING CHEMICAL WARFARE SERVICE

War Department.
Washington, June 28, 1918.

I—(1) Under authority conferred by Sections 1, 2, 8 and 9 of the Act of Congress, "Authorizing the President to increase temporarily the military establishment of the United States," approved May 18, 1917, and the Act "Authorizing the President to co-ordinate or consolidate executive bureaus, agencies, and offices, and for other purposes, in the interest of economy and the more efficient concentration of the Government," approved May 28, 1918, in pursuance of which Act the President has issued an Executive Order dated June 25, 1918, placing the experiment station at American University under control of the War Department, the President directs that the gas service of the Army be organized into a Chemical Warfare Service, National Army, to include:

(a) The Chemical Service Section, National Army.

(b) All officers and enlisted men of the Ordnance Department and Sanitary Corps of the Medical Department as hereinafter more specifically specified (regular officers affected being detailed and not transferred).

(2) The officers for this service will be obtained as provided by the third paragraph of Section 1 and by Section 9 of the Act of May 18, 1917, the enlisted strength being raised and maintained by voluntary enlistment or draft.

(3) The rank, pay, and allowances of the enlisted men of the Chemical Warfare Service, National Army, shall be the same as now authorized for the corresponding grades in the Corps of Engineers.

(4) The head of the Chemical Warfare Service, National Army, shall be known as the Director of the Chemical Warfare Service, and, under the direction of the Secretary of War, as such, he shall be, and hereby is, charged with the duty of operating and maintaining or supervising the operation and maintenance of all plants engaged in the investigation, manufacture, or production of toxic gases, gas-defense appliances, the filling of gas shells, and proving grounds utilized in connection therewith and the necessary research connected with gas warfare, and he shall exercise, full, complete, and exclusive jurisdiction and control over the manufacture and production of toxic gases, gas-defense appliances, including gas-shell filling plants and proving grounds utilized in connection therewith, and all investigation and research work in connection with gas warfare, and to that end he shall forthwith assume control and jurisdiction over all pending Government projects having to do or connected with such manufacture, production, and operation of plants and proving grounds for the Army and heretofore conducted by the Medical Department and Ordnance Deparment under the jurisdiction of the Surgeon General and the Chief of Ordnance, respectively, and all material on hand for such investigation or research, manufacture or production, operation of plants and proving grounds and all lands, buildings, factories, warehouses, machinery, tools and appliances, and all other property, real, personal, or mixed, heretofore used in, or in connection with, the operation and maintenance of such plants and proving grounds for the purpose of investigation or research, manufacture or production, already procured and now held for such use by, or under the jurisdiction and control of, the Medical Department of the Ordnance Department, all books, records, files, and office equipment used by the Medical Department or the Ordnance Department in connection with such investigation or research, manufacture or production, or operation of plants and proving grounds, all rights under contract made by the Medical Department or Ordnance Department in, or in connection with, the operation of such plants and institutions as specified herein, all rights under contract made by the Medical Department or Ordnance Department in, or in connection

with, such work, and the entire personnel (commissioned, enlisted, and civilian) of the Ordnance Department and Sanitary Corps of the Medical Department as at present assigned to or engaged upon work in, or in connection with, such investigation or research, manufacture or production, or operation of plants and proving grounds, are hereby transferred from the jurisdiction of the Ordnance Department and the Medical Department and placed under the jurisdiction of the Director of the Chemical Warfare Service, it being the intention hereof to transfer from the jurisdiction of the Medical Department and the Ordnance Department to the jurisdiction of the Director of the Chemical Warfare Service every function, power, and duty connected with the investigation, manufacture, or production of toxic gases, gas-defense appliances, including the necessary research connected with gas warfare, gas-shell filling plants, and proving grounds utilized in connection therewith, all property of every sort or nature used or procured for use in, or in connection with, said operation of such plants and proving grounds and the entire personnel of the Ordnance Department and Sanitary Corps of the Medical Department as at present assigned to, or engaged upon work in, or in connection with, the operation and maintenance of such plants engaged in the investigation, manufacture, or production of toxic gases, gas-defense appliances, including gas-filling plants and proving grounds utilized in connection therewith.

(5) All unexpended funds of appropriations heretofore made for the Medical Department or Ordnance Department and already allotted for use in connection with the operation and maintenance of plants now engaged in, or under construction for the purpose of engaging in, the investigation, manufacture, or production of toxic gases or gas-defense appliances, including gas-shell filling plants, are hereby transferred to, and placed under the jurisdiction of, the Director of the Chemical Warfare Service for the purpose of meeting the obligations and expenditures authorized herein; and, in so far as such funds have not been already specifically allotted by the Medical Department and the Ordnance Department for the purposes specified herein, they shall now be allotted by the Secretary of War, in such proportions as shall to him seem best intended to meet the requirements of the situation and the intentions of Congress when making said appropriations, and the funds so allotted by the Secretary of War to meet the activities of the Chemical Warfare Service, as heretofore defined herein, are hereby transferred to, and placed under the jurisdiction of, the Director of the Chemical Warfare Service for the purpose of meeting the authorized obligations and expenditures of the Chemical Warfare Service.

(6) This order shall be and remain in full force and effect during the continuation of the present war and for six months after the termination thereof, by proclamation of the treaty of peace, or until theretofore amended, modified, or rescinded.

II—By direction of the President, Maj. Gen. William L. Sibert, United States Army, is relieved from duty as Director of the Gas Service, and is detailed as Director of the Chemical Warfare Service, National Army.

By Order of the Secretary of War.
[322.06 A. G. O.] PEYTON C. MARCH,
General, Chief of Staff
[Official] H. P. McCAIN,
The Adjutant General.

PERSONNEL OF C. W. S.

The following list of the heads of the various divisions and sections, together with the commissions thus far awarded, indicate the functions of each official and the manner in which the organization will be enabled to operate as a unit:

Director and Staff.

DIRECTOR.

Major General William L. Sibert.

STAFF.

Col. W. J. L. Lyster, S. C., Medical Officer; Capt. H. C. Bradley, Assistant.

Lt. Col. C. B. Thummel, O. D., Ordnance Officer; Maj. C. S. Stevenson, C. W. S., Assistant.

Maj J. H. Brightman, Representative of British Military Mission.

Headquarters Division.

ASSISTANT DIRECTOR.

Col. H. C. Newcomer, C. E.

(To act for the Director in his absence, in charge of all military matters and new projects. Chairman, Board of Review.)

Military Assistants.

Maj. J. H. Walton, C. W. S.; Capt. J. S. Baker, C. W. S.; Capt. V. L. Bohnson, C. W. S.; Capt. A. Bolenbaugh, C. W. S.; Capt. S. J. Delancy, C. W. S.; First Lt. R. C. Henderson, C. W. S.; Second Lt. F. C. Perkins.

Technical Assistants.

Maj. S. A. Tucker, C. W. S.; Capt. R. Franchot, Capt. G. M. S. Tait, C. W. S.; First Lt. L. Van Doren, C. W. S.

OFFICE ADMINISTRATION.

Maj. W. W. Parker, C. W. S.

(In charge of files and clerical personnel, receipt and distribution of mails, collection and transmission of papers between various sections of the office, office disbursements.)

Assistants.

First Lt. F. W. Dasher, C. W. S.; Second Lt. B. W. Tipton, C. W. S.; Second Lt. W. F. Kunkle, C. W. S.; Second Lt. W. D. Towler, C. W. S.

RELATIONS SECTION.

Col. M. T. Bogert, C. W. S.

(In charge of relations with Universities, with industries, with the office of the Director of Purchases, Storage and Traffic, and with the War Industries Board, including its committees.)

Assistants.

Maj. Victor Lenher, C. W. S.; Capt. C. V. Sheehan, C. W. S.; Maj. W. J. Noonan, C. W. S.; Capt. W. H. Hickin, C. W. S.; Maj. Allen Rogers, C. W. S.; First Lt. H. F. Scharer, C. W. S.; Maj. Samuel Avery, C. W. S.; Mr. Geo. S. Case, C. W. S.

PERSONNEL SECTION.

Maj. F. E. Breithut, C. W. S.

(In charge of all matters pertaining to procurement and assignments of commissioned and enlisted personnel of the Chemical Warfare Service.)

Assistants.

First Lt. G. W. Phillips, C. W. S.; First Lt. H. B. Bramlet, C. W. S.; Second Lt. A. E. Case, C. W. S.

CONTRACTS AND PATENTS SECTION.

Capt. W. K. Jackson, C. W. S.

(In charge of Section, Member of Board of Review.)

Assistant.

Capt. R. B. Meckley, C. W. S.

FINANCE SECTION.

Maj. C. C. Coombs.

(In charge of estimates, appropriations and allotments, of administrative audit of all disbursing accounts and of property. Member of Board of Review, C. W. S.)

Assistant.

Capt. Ben Jenkins, C. W. S.

REQUIREMENTS AND PROGRESS SECTION.

Capt. S. M. Cadwell, C. W. S.

(In charge of Section.)

Assistant.

Second Lt. J. A. Sohen, C. W. S.

CONFIDENTIAL INFORMATION SECTION.

Maj. S. P. Mulliken, C. W. S.

(In charge of Section.)

Assistant.

Second Lt. H. E. Moore, C. W. S.

TRANSPORTATION SECTION.

(Officer in charge not yet selected.)

Assistant.

Capt. H. R. Sharkey, C. W. S.

Field Organization.

GAS OFFENSE DIVISION.

Officer in Charge, Col. W. H. Walker.

(The production of gas, containers and other material for use in offensive gas warfare.)

GAS DEFENSE DIVISION.

Officer in Charge, Col. Bradley Dewey.

(The production of material such as gas masks for use in the defensive.)

PROVING DIVISION.

Officer in Charge, Maj. W. S. Bacon.

(Charged with the duty of proving the efficiency of material under field conditions.)

DEVELOPMENT DIVISION.

Chief, Col. Frank M. Dorsey.

(For the development of material received from the Research Division to the point where it may be turned over for proving.)

RESEARCH DIVISION.

Chief, Col. G. A. Burrell.

(Charged with research into all matters pertaining to gas warfare.)

EUROPEAN DIVISION.

(This division includes personnel assigned to all divisions and corps and army headquarters in addition to those required for the supply of material in the field in France.)

MEDICAL DIVISION.

Officer in Charge, Col. W. J. L. Lyster.

Commissioned Officers.

MAJOR GENERAL.

William L. Sibert.

COLONELS.

Raymond F. Bacon
Marsten F. Bogert
George A. Burrell
Bradley Dewey
William H. Walker

LIEUTENANT COLONELS.

Arthur L. Besse
Edwin M. Chance
Wm. McPherson
Jas. F. Norris
Chas. F. Vaughn

MAJORS.

Chas. Almy, Jr.
Samuel A. Avery
Wm. S. Bacon
Theo. H. Barth
Fred'k E. Breithut
T. Mitchell Chance
Edward B. Clark
J. B. Conant
Dara J. Demerest
Fred'k A. Dewey
Edgar M. Dunn
Wm. L. Evans
Francis C. Frary
Edw. E. Free
Wm. G. Gallowhur
Hugo H. Hanson
Percy D. Haughton
Arthur M. Heritage
Clean R. Johnson
W. Catesby Jones
Victor Lenher
William G. Lockwood
Frank W. Mack
Stephen R. Morey
Samuel P. Mulliken
Adrian Nagelvoort
Wm. J. Noonan
Walter W. Parker
Philip L. Reed
Chas. E. Richardson
Allen Rogers
Reed P. Rose
Henry P. Schuit
Wm. O. Sibert
Theo. W. Sill
Oscar E. Stevens
C. S. Stevenson
Orland R. Sweeney
Sterling M. Temple
Samuel A. Tucker
Edgar D. Van Keuren
Frank J. Wagner
J. H. Walton
Irving W. Wilson
Robert E. Wilson
John C. Woodruff
Chas. R. Wraith
Arcalons W. Wyckoff
Frederick G. Zinsser

CAPTAINS.

John A. Armory
James Armstrong
Kirby Atterbury
J. Stanley Babbitt
R. O. Bailey
Ross A. Baker
T. W. Balfe
Lawrence L. Beebe
A. T. Larson
Lewis L. Latimer
James Lawrence
Stanley H. Lawton
Arthur C. Levering
John S. Little
Harris Livermore
Paul R. Llewellyn

Otto S. Beyer
R. E. Bishop
Kenneth B. Blake
Ross C. Blanchard
T. W. Bliss
Geo. W. Blossom
V. L. Bohnson
J. H. Bogart
A. Bolenbaugh
Dale M. Boothman
Carl G. Bopp
Paul H. M. P. Brinton
Nath'l B. Brodhead
Wm. E. Brophy
H. E. Bruce
Arthur R. Burns
Horace G. Byers
Samuel A. Byrne
Sidney M. Cadwell
M. U. Campau
Paul M. Carleton
Charles H. Chaar
Charles C. Shalfant
Henry P. Chandler
Richard M. Clucas
Wm. H. Coburn
Chas. B. Colby
W. H. Coleman
Lester C. Cover
Rolph H. Crocker
Lowell E. Dana
Thos. J. Dee
S. J. Delancy
Arnold C. Dickinson
Marion G. Donk
Levi B. Duff
Frank R. Flood
Harold B. Foster
Lester E. Fulford
H. L. Garner
H. A. Gartner
Paul M. Giesy
Benj. Gill
William S. Godfrey
Robt. D. Gordon
Robt. C. Gowdy
Robert McC. Graham
Caswell Graves
Winfield S. Grove
Harold G. Guiteras
Ralph R. Hall
H. S. Harned
Clarkson E. Harshberger
Fred L. Hayden
Wayne Herkness
Michael Y. Heath
Wilyn Herbert
Erle C. Herman
William H. Hickin
Wm. E. Hoffman
Ben. Jenkins
Wm. DeY. Kay
A. W. Kenney
Waldemar Kops
Richard L. Kramer

Wm. G. Lockwood
Chas. F. Long
Fred'k A. Lovell
F. L. Lyon
Wm. H. McAdams
A. G. McChesney
Thos. T. McGovern
David J. McGrath
Wm. J. McKenna
Wm. S. McKinney
Leonard Macomber
Wm. C. Martin
Robt. B. Meckley
R. P. Melendy
Hamilton Merrill
Hudson C. Millar
R. W. Millar
John H. Northrup
Geo. G. Oberfell
G. A. Parks
L. W. Parsons
Stuyvesant Peabody
Chas. H. Pearce
Raymond V. Puff
R. R. Renshow
Jos. C. Richardson
Wm. M. Rile
O. E. Roberts
Wm. O. Robinson
Geoffrey M. Rollason
Hugh W. Rowan
John D. Rue
Jos. B. Russell, Jr.
E. K. Ruth
Berthold E. Schlesinger
Victor B. Schmidt
John S. Selfridge
Harold C. Sharpe
Edmund J. Shattuck
George Edward Shaw
Charles V. Sheehan
Jos. E. Silver
Raymond T. Smith
Frederick H. Smyth
Edward L. Stapleton
Leslie T. Sutherland
Godfrey M. S. Tait
David P. Taylor
Red'd E. Taylor
M. C. Teague
Thos. E. Thompson
Benj. H. Throop
Harland L. Trumbell
Roy H. Uhlinger
Stuart D. Warner
Harry E. Wells
L. G. Wesson
Thorne L. Wheeler
H. D. Whitehouse
Chas. M. Whitlock
J. A. Wilkinson
Herbert Winkelmann
James S. Wolf
Alfred W. Wood
Burnett Wright

FIRST LIEUTENANTS.

Abrahams, Clinton D.
Abrams, Allen
Adams, James F.
Andrus, Leanonard A.
Armstrong, Charles D.
Arnold, H. C.
Ashe, Lauron H.
Ashman, L. A.
Ashman, L. H.
Ayer, Paul P.
Bailey, Albert E.
Beal, William D.
Bear, H. K.
Becker, Hasen K.
Bedford, Edward T.
Bell, Thomas R.
Bennett H. S.
Best, Arthur F.
Bogue, Joseph C.
Boon, C. J.

McNeil, Winfield I.
McWilliams, John C.
MacConnell, John G.
MacDonald, Alexander D.
MacNeill, N. M.
Mahlman, Osburn L.
Manning, Edwin C.
Mansur, Charles I.
Marshall, William D.
Martin, H. A.
Mayer, Gustave
Mayham, Ray E.
Merrill, Leslie M.
Merryman, James R.
Mitchell, John H.
Moffitt, H. R.
Morawski, Frederick
Morgan, A. M.
Mott, John
Moulton, Paul B.

Bramlet, Hubert B.
Bristow, James J.
Brock, Earle A.
Brodesser, R. E.
Brown, Carl H.
Brown, Lester B.
Burt, R. A.
Cahill, Michail
Callemon, Clarence B.
Clark, S. C.
Clarke, Theodore
Clifford, C. W.
Cochran, Marshall G.
Coghlan, S. R.
Colebrook, M. W.
Collotte, W. R.
Conohay, John R.
Cox, Samuel F.
Crossfield, Albert S.
Cuff, James B.
Dasher, Frances W.
Davidson, A.
Davidson, Joseph G.
Davis, George W.
Dunbar, Noel S.
Dwyer, C. E.
Eason, Harry M.
Eaton, Harry A. F.
Eldon, John A.
Eldridge, Arthur C.
Elliott, Lowell A.
Elsbey, Alden G.
Emory, Stuart R.
Esser, Alvah E.
Fairbanks, Herbert S.
Fairchild, Tappon
Felsing, W. A.
Fitzgerald, Heber D.
Fleming, Walter F.
Frederick, E. L.
Fuller, E. W.
Gage, Roscoe M.
Gaines, O. I.
Gibson, Richard
Gruse, William A.
Gurney, Harold P.
Hartshorn, E. B.
Hayden, E. M.
Henderson, L. M.
Heneage, Thomas H.
Hentz, William A.
Hetherington, George F.
Hillery, Harry M.
Hobson, H. T.
Hoguet, Rene
Holland, Martin A.
Holm, George E.
Holmes, Raymond M.
Hooper, Noel J.
Horton, Winthrop S.
Howe, Robert A.
Howlett, Arthur E.
Hudson, H. H.
Hudson, W. E.
Hull, Edwin J.
Iddles, Alfred
Jackson, William M.
Johnson, Robert L.
Jones, Spencer L.
Katz, Sidney H.
Keller, Alexander W.
Kellogg, Edward A.
Kempton, Robert E.
Kerns, J. T.
Kerr, George M.
Klauber, Murray
Kienle, R. H.
King, Arthur G.
King, John L.
King, T. S.
Kipka, Ross E.
Kirkpatrick, Walter M.
Kolden, Dudley F.
Lamb, Lloyd B.
Lambert, Marion L. J.
Latson, Frank W.
Leavitt, George F.
Lee, Elwood B.

Mueller, William A.
Mulford, William J.
Murphy, Alfred L.
Murtfeldt, W. Scott
Nasseit, Harry B.
Noble, Edson J.
Norlin, F. C.
Northrup, William C.
Norton, F. A.
O'Brein, Bernard
Ott, J. E.
Patterson, G. P.
Perkins, Granville A.
Perrett, G. St. J.
Phillips, George W.
Pierce, Edward T.
Pratt, Francis S.
Prentice, Philip B.
Procoter, William R.
Pyle, David H.
Racicot, P. A.
Rahn, Reinhard
Ranson, William J.
Rapee, Frank J.
Rector, Thomas N.
Regan, Edward F.
Reiling, Howard A.
Riddell, John F.
Rixey, Eppa
Rogers, Rollins W.
Romilly, Edgar P.
Royce, Harrison S.
Russell, G. P.
Rutledge, George F.
Sampson, Ernest
Sawders, J. C.
Scery, J. W.
Schaufele, H. J.
Scheirz, E. R.
Schmidt, Mott B.
Schultz, Addie B.
Schwarz, M. W.
Shaw, Guthrie
Shaw, Joseph T.
Sibert, Eugene
Silsbee, James A.
Smith, Lawrence W.
Smith, Lee I.
Smith, Leslie D.
Smyth, C. P.
Spaulding, E. G.
Spriggs, C. I.
Staples, Scott D.
Steenken, F. L.
Steinbach, E. S.
Stephens, Charles W.
Stupp, John G.
Swanson, F. J.
Suydam, John R., Jr.
Talbot, John C.
Talcott, Harrison W.
Thomas, Richard W.
Todd, William T.
Towler, Thomas W.
Trenkman, Frederick
Truax, Harold W.
Trubee, William E.
Tuttle, Neal
Urquhart, George R.
Van Doren, Lloyd
Vile, Norman B.
Vincent, Max G.
Visscher, Raymond
Wallace, E. S.
Walsh, James F.
Wangler, Albert F.
Warden, Edward W.
Watson, Warren M.
Weeks, Robert W.
Weinert, R. E.
Wells, Arthur G.
Welsh, Thomas W. B.
Wemple, Holland R.
Whetzel, Joshua C.
Willis, Oliver E.
Wilson, John E.
Wilson, Otto
Winter, Edwin M.

Lewis, Walter H.
Leyden, James, Jr.
Lloyd, Edward C.
Long, David R.
Long, Howard A.
McBride, George H.
McCoy, John G.
McCune, J. S.
Wiswall, Paul N.
Withington, Lathrop
Woodbury, Horace G.
Woodruff, William W.
Woodward, Paul G.
Yablick, Max
Yoe, John H.
Zimmerman, Joseph
Philip R. McCurdy

SECOND LIEUTENANTS.

Bangs, E. C.
Barrho, W. H.
Barren, Edmund D.
Battley, J. F.
Benton, Arthur F.
Biance, Fred
Blank, J. F.
Blicke, Frederick F.
Bliss, Roland R.
Bly, Robert S.
Beardman, Roland S.
Borbeck, Archibald F.
Bowers, Paul C.
Bowes, Almond N.
Bowman, Lee
Brown, Raymond G
Carry, John R.
Case, Arthur E.
Chaplin, John H.
Charron, Roy C.
Clark, Ernest M.
Diven, John M
Donoho, J. B.
Dunn, J. S.
Duckworth, John S.
Ellison, A. D.
Embree, Spencer D.
Emmons, W. H.
Fannan, H. B.
Funsten, S. R.
Giles, Jeremiah D.
Greninger, R. R.
Gross, Paul M.
Hammond, William A.
Harper, Walter J.
Heath, John R.
Heffner, Oden C.
Heidingsfeld, Ralph
Heins, Ralph W.
Hood, Harrison P.
Huff, W. J.
Jennings, M. E.
Kearns, J. J.
Kinney, Selwyne P.
Kunkle, Walter F.
Levy, Gaston J.
Lindsay, Walter S.
Loeb, Edward H.
McKenzie, Clyde
McLane, Howard B.
Milligan, Lowell H.
Moore, Herbert E.
Oamer, John W.
Overstreet, John B.
Page, C. W. C.
Pease, Robert N.
Pelton, Harold A.
Penfield, F. Joel
Penfield, Richard
Perkins, F. C.
Pettengill, Francis W.
Probeck, E. J.
Rees, John G.
Reichert, S. Joseph
Reyerson, Lloyd H.
Richardson, George C.
Ross, William B.
Rothchild, Henry A.
Rundlett, Arnold D.
Schweizer, James A.
Serson, Fred J.
Shakman, J. G.
Shannanhouse, J. G.
Sharer, Ralph K.
Smith, Charles V.
Schon, Julian A.
Spofford, Charles B., Jr.
Stone, Sam P.
Thorp, Gerald
Tipton, Ben. W.
Towler, Eugene D.
Vealey, W. D.
Walther, Owen N.
Weber, Harold C.
Woodbury, V. P.
Woods, Basil G.
Killam, Luther L.

Commissioned Officers Overseas.

COLONELS.

Ardery, Edward A.
Bacon, Raymond F.
Fries, Amos A.
Johnston, Edward N.
John W. N. Schulz

LIEUTENANT COLONEL.

James F. Norris

MAJORS.

Connel, Karl
Hamor, William R.
Hildebrand, Joel H.
Lewis, Gilbert N.
Lockwood, William G.
Richardson, Charles E.
William O. Sibert

CAPTAINS.

Akers, James Greaff
Corrill, Charles H.
Corry, Edwin E.
Cutler, Thomas H.
Douglas, Stephen A.
Eldredge, Orrin S.
Goss, Byron G.
Hardesty, George R.
Hunt, George A.
Joly, Charles L.
Keyes, Frederick G.
Markall, Colin
Nicolet, Ben H.
Patterson, Earl
Perry, Glenn L.
Pope, Frederick
Ray, Arthur B.
Rollason, Geoffrey M.
Rowan, Hugh W.
Smith, Earl C.
St. John, Adrian
Taylor, Alfred L.
Torry, Harry W.
Urbain, Leon F.
Ward, Ralph D.
Zanetti, J. Enrique

FIRST LIEUTENANTS.

Alden, J. L.
Allen, Roger E.
Maynard, Leonard A.
Meserve, Philip W.
Anderson, Harry P.
Ashe, Lauren H.
Bach, Ronald P.
Barnett, Joseph J.
Barry, John G.
Blakney, George P.
Bowman, Reginald C.
Clancy, Richard W.
Clapp, Dudley
Clarkson, John L.
Cole, Howard I.
Cool, Claude A.
Crenshaw, James L.
Cretcher, Leonard H.
Dale, Stewart T.
Darling, Harry C.
Eaton, Harry A. F.
Fisher, Abram M.
Francke, Hugo
Gauger, Alfred W.
Goldschmidt, Samuel
Gordon, Marcus A.
Hartshorn,, Fred M.
Hunter, Robert C.
Keitt, George W.
Knox, W. L.
McGowan, Henry G.
Mack, Edward
Morgan, John D.
Murphy, Ray V.
Noer, Oyvind J.
Norton, Arie R.
Nowry, Irvin W.
Olson, A. R.
Parks, James G.
Parmelee, Paul R.
O'Brein, Bernard
Popp, Earl C.
Rambo, Joseph D.
Rhode, Leon M.
Robinson, Charles R.
Rowe, David H.
Salisbury, Donald W.
Senior, James K.
Shaw, Leon I.
Sidelinger, Roy L.
Stearns, Albert M.
Stump, Horace E.
Thomas, Ralph M.
Thompson, Louis E.
Vanvoorsees, Harold E
Walker, Lester V.
Whiton, Louis G.
Wightman, Eugene P.
Williamson, Robert B.
Wilson, David W.
Wildred A. Wylde

SECOND LIEUTENANTS.

Acker, Ernest R.
Austin, Robert W.
Birckhead, Peter H.
Bowers, Paul C.
Bowman, Ira J.
Brumhalt, John W.
Conrad, Frederick U.
Crowell, George W.
Davidson, Benjamin B.
Dennis, Richard C.
Dunn, Charles K.
Eiselot, Lewis G.
Hall, Robert B.
Hast, Julian A.
Higbee, Clarence W.
Holt, Herbert B.
Hooker, Albert H.
Knapp, Ralph
Law, James D.
McNaugher, Joseph W.
Miller, Russell W.
Neff, Chester M.
Nichols, H. Janney, Jr.
Pauly, Robert C.
Peck, Edward B.
Ribble, Keith P.
Riker, Carlton B.
Robinson, Otto L.
Sebastian, Roubon L.
Scheetz, Francis H.
Scott, Warren R.
Shaw, Ellis M.
Skinner, Glenn S.
Stuarn, James V.
Taylor, David B.
Thayer, Bruce W.
Thompson, Frank B.
Wannemaker, George
White, James M.
Wright, Douglas B.

The Delora Co. Incorporated.

Chemicals, etc., will be manufactured by the recently incorporated Delora Co., New York City. The capital of the company is $250,000 and the incorporators are E. S. M. Selig, A. B. Crawford and F. Aranow.

Liberty Chemical Company.

The Liberty Chemical Company has been incorporated under the laws of New Jersey at Woodridge, that state, with a capital of $50,000 to manufacture chemicals. The incorporators are Victor L. King, Eugene C. King and Charles R. Ruegger.

American Woodpulp Now Has Chemical Plant.

Announcement has been made by the American Woodpulp Corporation, New York City, that in addition to its regular line of business there has been added to the plant a chemical department in charge of Alfred J. Marcus, formerly of the firm of Monnier & Marcus.

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By CARLETON ELLIS and A. A. WELLS[*]

Part XVII

Absorption of Ultra Violet Light.

Observations on the absorption of ultra violet light by compounds in a liquid or vaporous state have shown the invisible spectrum to be a means of examination of inorganic and organic bodies and probably one which the chemist ultimately will add to the usual routine of laboratory practice. Some extended and the ultra violet region have been made, especially in the field of organic chemistry. Bodies of different constitution reveal characteristic absorption spectra in many cases, isomeric compounds may be compared and double or triple bonding oriented to a considerable degree. The development of this little known field of investigation of the ultra violet ray, is therefore highly promising.

Determination of Small Quantities of Ozone.

Hallwachs (Ann. Physik. 1909 (iv), 30, 602) has shown that small quantities of ozone can be estimated photo-electrically by reason of the large specific absorptive power of the gas for ultra violet radiation of wave-length in the neighborhood of $258\mu\mu$. For such measurements the pressure of the gas in the absorption tube should be of the order of 0.01 mm. of mercury. On the assumption that the photoelectric effect is proportional to the intensity of the incident light, *Krüger* and *Mueller* (Physikal. Zeitsch., 1912, *13*, 729) have measured the absorption of ultra violet light of wave-length $\lambda = 254\mu\mu$ in ozonised oxygen with the aid of a photo-electric cell containing a potassium electrode in contact with hydrogen at a pressure of 0.3 mm. The results obtained with different samples are in good agreement with those found by the iodine method, and it is shown that the optical method can be employed for smaller concentrations than the chemical method, the lower limit being about 0.001 per cent. *Fabry* and *Buisson* (Compt. rend., 1913, *156*, 782) have made a determination of the variations of "a," the constant of absorption for ozone, as defined by the equation $I = I_0 10^{-ad}$, where I and I_0 are the intensities of the light before and after absorption, and d the thickness in centimeters of pure gaseous ozone, λ varying from 2,300 to 3,400. The maximum absorption takes place at λ 2,550, is very high at this point, and the absorption varies rapidly between 2,900 and 3,300, the value of "a" being given by $\log a = 17.58 - 0.00564\ \lambda$. From these results, combined with measurements made on the amount of light from the sun transmitted by the atmosphere, Fabry and Buisson draw the conclusion that the ozone content of the atmosphere, if evenly distributed, would be equal to 0.6 cubic centimeters per cubic meter of air.

Ozone and Sunlight.

Meyer (Ann. Physik., 1903, (iv), 12, 849) has determined the value of the absorption coefficient of ozone over the range $\lambda = 185\mu\mu$ to $\lambda = 300\mu\mu$, and finds a minimum value at $\lambda = 205\mu\mu$ and a maximum at $\lambda = 258\mu\mu$. The latter agrees with the position ($\lambda = 256\mu\mu$) of the absorption band given by Hartley (J. Chem. Soc., Trans., 1881, 39, 60, 111). The sun's spectrum comes more or less suddenly to an end at $\lambda = 293\mu\mu$, and the absorption of the solar radiation in the earth's atmosphere, which is responsible for that fact, is, according to Hartley, due to the ozone. Taking into account the percentage of ozone in the atmosphere and the values of the absorption coefficient obtained by himself, Meyer regards Hartley's views as probably correct.

Liquid Ozone.

By the evaporation of liquid ozone, a gas containing a high percentage of ozone is obtained, which is prone to explode. The absorption spectra of liquid and gaseous ozone have been examined photographically and thermoelectrically. *Ledanburg* and *Lehmann* (Chem. Centr., 1906, i, 1727; Ber. Deut. phys. Ges., *4*, 125) when using gaseous ozone in small concentrations found the absorption reached to about $316\mu\mu$ in the ultra violet, but as the concentration increased, new bands appeared and extended into the region of longer wave-length. Liquid ozone did not show any absorption bands in the visible spectrum and there were no bands in the ultra violet.

Absorption of Ultra Violet Rays by Tap-Water.

The observation that the electrical action of ultra violet light is diminished very much more by passing through tap-water than through distilled water led Pidduck (Phil. Mag., 1909, (iv), 17, 710) to examine the absorption power of dilute solutions. The dependence of the absorption on the concentration of the solution was investigated in the case of sodium chloride and potassium bromide, the latter salt being more active than the former. The absorption of light by water is changed by the presence of strongly hydrated salts, as shown by the radiometer, according to *Guy, Schaeffer* and *Jones* (J. Physikal. Zeitsch., 1913, 14, 278; Amer. Chem. J., 1913, 49, 265; J. Chem. Soc. 1913, Abs. *104*, ii, 362).

Hydrogen Peroxide.

Various authors have observed the presence of hydrogen peroxide in solutions of radioactive salts, but, in considering the absorption of ultra violet light by radioactive elements and their degradation products, Zelinsky regarded the part played by the hydrogen peroxide formed under the influence of radium as small. *Rosanoff* (J. Russ. Phys. Chem. Soc., 1912, *44*, 1146; J. Chem. Soc. 1912, Abs. 102, ii, 875) investigated the absorption spectra of ultraviolet light by solution of hydrogen peroxide of various concentrations, and draws the conclusion that it is highly probable that the absorption of short waves by radioactive substances is conditioned by two factors: by the emanation developed, and, to a considerable extent, by the hydrogen peroxide formed under the influence of this emanation. As these two factors exist together, it is difficult to decide which of them plays the larger part in the absorption. The magnitude of the absorption may be taken as a measure of the degree of activity of the substance only when this is used in the solid state.

---

[*] All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

Iodine.

The absorption spectrum of iodine has been examined by *Wood* (Phil. Mag., 1912 (vi), 24, 673; J. Chem. Soc., 1912, Abs., 102, ii, 1018) with the aid of a spectrograph of very high resolving power, with the result that the visible region is found to contain a vast number of lines, which is estimated at more than 50,000. The sodium and bromine absorption spectra are equally complex, and it would appear that a large number of lines in the bromine and iodine spectra are coincident. This may be due to the occurrence of identical systems of electrons in the two elements, giving rise to the same series of frequencies.

The resonance spectra of iodine excited by the green and yellow lines of mercury have been further examined by *Wood* (Phil Mag., 1913 (iv), 26, 828; J. Chem. Soc., 1913, 104, ii, 994). By operating the mercury vapor lamp with different resistances in circuit it was found possible to vary the width of the exciting line so as to cover a variable number of iodine absorption lines, and the resonance spectra obtained under these circumstances have been carefully compared. In the earlier work it was assumed that each of the bright resonance lines coincided with one or other of the numerous absorption lines, but it is now found that this is not the case. The vapor always emits a line, the wave-length of which is identical with that of the exciting light. This line, termed the resonance radiation line, is accompanied by companion lines which form a group very similar in appearance to the other groups which appear at intervals along the spectrum. by reducing the density of the iodine vapor in the resonance tube it is found that the band spectrum is emitted. This spectrum is more strongly absorbed by the iodine vapor than the lines of the resonance groups. There is apparently no phosphorescent effect in the emission of the resonance spectrum.

Ribaud (Compt. rend. 1913, 157, 1065) has measured the co-efficients of absorption of bromine vapor in ultra violet light by taking two photographs side by side with the same duration of exposure, one having passed through the bromine, and the other having the intensity of light reduced in a known ratio, and seeking in the two photographs the region where the blackness is the same, thus getting the co-efficient of reduction and the index of extinction for the given wave-length. Measurements were made with the bromine vapor under various pressures, the results showing that the index of extinction is proportional to the pressure. Ribaud considers that the kinetic theory of absorption does not hold good for broad bands, but for the fine rays it accounts for the facts observed.

A study of the ultra violet absorption spectra of sulphur dioxide sulphurous acid and its salts and esters, hypochlorous acids and its salts and esters, chlorine dioxide, chlorous acid and the chlorites, and nitric acid, nitrates and alkyl nitrates, has been made by *Schaefer* (with Higgemann and Köhler) (Zeitsch. Elektrochem., 1915, 21, 181) over a large range of concentration and variation of experimental conditions.

Sulphurous Acid and Sulphites.

Garrett (J. Chem. Soc., Trans., 1915, 107, 1324) has made the extinction measurements with solutions of sulphurous acid, rubidium hydrogen sulphite, potassium hydrogen sulphite, sodium sulphite, ammonium sulphite, sodium metabisulphite, potassium metabisulphite, acetone sodium hydrogen sulphite, potassium sodium sulphite, sodium sulphite and symmetrical and unsymmetrical diethyl sulphites. These measurements were made with a Hilger quartz spectrometer and a nickel spark as illumination.

Ultra Violet Absorption of Sodium Vapor.

The ultra violet absorption spectrum of sodium vapor consists of a Balmer series of lines, of which *Wood* (Phil. Bag., 1918 (iv), *16*, 945; J. Chem. Soc., 1909, Abs., *96*, ii, 106), in his earlier work, photographed thirty, this making the longest Balmer series know. In this series the D-lines appear as the third member, while the end is at 2411. The photographs were obtained by passing the light from a cadmium spark through a steel tube about one meter long containing sodium vapor at dull-red heat under a nitrogen pressure of 15 centimeters. By making use of a large quartz spectrograph the Balmer series of double lines have been increased by Wood (Phil. Mag., 1909, *18*, 530; J. Chem. Soc., 1909, Abs., *96*, ii, 845) from thirty to forty-eight. The higher members of the series make their appearance as the density of the sodium vapor is increased, and simultaneously the lower members of the series are obliterated by channeled spectra which accompany them. These channeled spectra are analogous to that which accompanies the D-lines, but the constitution of the former is somewhat different, in that they spread out in both directions above and

(*Concluded on page 392*)

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors. Synthetic Medicinals, Flavors and Perfumes. Explosives, Photographic Developers.

Tanning Materials from Phenol

Edmund Stiasny, of Headingley, Leeds, England, assignor to the Badische Anilin and Soda Fabrik (Amer. Pat. 1,237,405, of Aug. 21,1917) describes a relatively simple method of transforming phenol and its homologues into active tanning agents. They result from condensing a monohydroxylated phenolic body with sulfuric acid and formaldehyde, under mild conditions, so that essentially products soluble in water are formed. The reaction can be effected either by treating a phenolic body with formaldehyde in the presence of dilute acid and then sulfonating the insoluble condensation products by treatment with strong sulfuric acid until they are soluble in water, or the reaction product of a phenolic body with concentrated sulfuric acid, or a phenol-sulfonic acid, or a mixture of a phenol and a phenol sulfonic acid, can be treated with formaldehyde. To avoid the formation of the known products which are insoluble in water and which may result by a violent action, care is to be taken that the process goes on under mild conditions, so as to cause a smooth reaction between the components. A rise of temperature due to the reaction should be avoided in any suitable way, such as by applying cooling during the reaction, at least when employing large quantities and a great strength of acid, a lower temperature being suitable when employing a strong sulfuric acid, and the reaction requiring a longer time when using a dilute acid than with a strong acid. The various conditions as to temperature, time, strength and quantities are therefore mutually dependent on one another, so that it is impossible to give definite limits of general validity for each of these factors. Exact conditions can easily be found out in each special case. The test is very simple: The conditions are properly chosen when the reaction mass dissolves in water and no considerable amount of insoluble, resinlike products separates out. Instead of formaldehyde itself, bodies which give rise to formaldehyde can be used, and instead of sulfuric acid, substituted sulfuric acids can be employed.

These new compounds are characterized by being light-colored amorphous substances containing organically bound sulfur. They are soluble in water, giving rise to almost colorless solutions which assume a red to blue color on the addition of a solution of ferric salt. They are capable of tanning hides and, like the usual tanning agents, do not completely permeate hides unmersed in the solutions within two hours.

The new compounds are probably diphenyl-methane derivatives. On treatment in a cold aqueous and slightly alkaline solution with a small quantity of alcoholic tetrachloroquinone, a coloring matter is formed.

The general method of preparation is illustrated by the following example:

Mix 4 kilos of phenol, or of cresol, with 4 kilos of concentrated sulfuric acid and heat the mixture for some time at from 100° to 120° C. The rise of temperature upon adding the phenol, or the cresol, to the sulfuric acid is usually sufficient to bring about the desired combination. The sulfonated mixture is cooled and treated with 900 cubic centimeters of 40% formaldehyde solution. Run this in slowly and cool the mixture to avoid any considerable rise of temperature. When the reaction is over, the product obtained is an almost colorless, viscous mass which is soluble in cold water. The solution can be employed directly as a tanning vat. Before use the reaction product can be treated with alkali, such as caustic soda, or soda, but it is not advisable to neutralize the mixture completely, or to make it alkaline.

Manufacture of Derivatives of Toluene, Chlorinated in the Side-Chain

Dr. H. D. Gibbs and George A. Geiger of the Bureau of Chemistry, Department of Agriculture, Washington, have recently devised a method for producing the various derivatives of toluene chlorinated in the side-chain, which promises to be of some importance in the dyestuff industry (Amer. Pat. 1,246.739, of Nov. 13, 1917).

The patent is dedicated to the public and can be used in the United States by any one without payment of royalty.

Heretofore various methods have been employed for the production of derivatives of toluene containing chlorine substituted in the side chain, among which are the following:

1. By passing chlorine into boiling toluene in the presence of light until a certain weight of the chlorine is absorbed, a mixture of the different chlorine compounds is produced. The principal products are those in which the chlorine is substituted in the side chain

but there are also present compounds containing chlorine in the ring.

2. On mixing gaseous toluene in excess and chlorine gas in the presence of light and a catalyst, only a portion of the toluene is attacked with the production of benzyl chloride. The latter is mixed with unattacked toluene and the catalyst and must be subjected to a purification process, which adds to the expense of the process.

3. By mixing gaseous toluene with an excess of chlorine gas in the presence of a catalyst a mixture of benzyl chloride, benzal chloride, benzotrichloride, chlortoluene, chlor-benzyl chloride, etc., is produced. This action is somewhat analogous to (1), above mentioned, due to the fact that the reaction takes place in successive stages and the yield of any one desired product can not be exactly controlled.

It is now found that when toluene, converted into the gaseous state, is mixed with chlorine gas in certain definite theoretical proportions in the presence of ultra violet rays, the desired products are produced in greatly increased yields and without the production of unfavorable, undesirable and interfering by-products.

For example:

1. When streams of gaseous chlorine and gaseous toluene are mixed in proportions agreeing with the following reaction:

$$C_6H_5CH_3+Cl_2=C_6H_5CH_2Cl+HCl$$

the principal product obtained is benzyl chloride.

2. When streams of gaseous chlorine and gaseous toluene are mixed in proportions agreeing with the following reaction:

$$C_6H_5CH_3+2Cl_2=C_6HCHCl_2+2HCl$$

the principal product obtained is benzal chloride (benzylidene chloride).

3. When streams of gaseous chlorine and gaseous toluene are mixed in proportions agreeing with the following reactions:

$$C_6H_5CH_3+3Cl_2=C_6H_5CCl_3+3HCl$$

the principal product obtained is benzotrichloride.

It has been found possible to approach these ideal conditions by carefully regulating the speed at which the gases are simultaneously introduced into the reaction chamber.

Moreover, it is advisable to work without the presence of a catalyst. It is not essential to the reaction and contaminates the product, thus adding to the expense of the process.

It is thus apparent that the invention introduces a decided improvement inasmuch as it is possible to produce certain particular derivatives of toluene containing chlorine in the side-chain without the presence of large quantities of other derivatives containing more or less chlorine.

The procedure for making benzyl chloride is as follows:

The reaction chamber consisting of material, resistant to all substances taking part in or produced by the reaction, is swept clear of air by the introduction of an inert gas, such as carbon dioxide. This reaction chamber is provided with a lamp such as the quartz mercury lamp, which emits ultra violet rays. The liquid toluene is then fed by means of a pump at the rate of 60 grams per minute into a vaporize heated by a resistance coil which converts it into the gaseous condition. The vapor is then led from the vaporizer into the reaction chamber. The chlorine is delivered from the cylinder, or electrolytic cell, through a measuring apparatus directly into the reaction chamber through a tube concentric with that of the toluene tube at the rate of 46 grams per minute. The product of the reaction collects on the bottom of the chamber and is drawn off at suitable intervals without the introduction of air. The hydrochloric acid formed is led off through the top of the chamber and absorbed in water.

For making benzal chloride or benzotrichloride the features outlined above are the same except that the rates of delivery of toluene and chlorine are different. To produce benzal chloride the toluene is delivered at a rate of 60 grams per minute and the chlorine at 92.5 grams per minute. For benzotrichloride the rates are, toluene 60 grams per minute, chlorine 139 grams per minute.

A Method for Condensing Salicylic Acid Vapor

It is common practice to volatilize salicylic acid at a temperature of between 130° C. and 160° C. with the aid of superheated steam to convey the acid vapour to the condenser. In a recent patent (Br. Pat. 106,616 of 1916), R. J. Pugh, of the London Chemical Works, Southall, Middlesex, describes a new process for the condensation of the vapor of volatilised salicylic acid from a mixture of that vapor with steam.

According to this method, salicylic acid vapor is condensed and separated from the steam by passing the mixture into a condensing chamber, part or whole of whose wall is pierced by capillary interstices through which the steam is transmitted so that condensation of the acid and its separation from the steam occur within the chamber, and more or less simultaneously. A convenient material for the wall is woollen canvas, but a variety of other materials are available, provided they are chemically free of iron and unattacked by salicylic acid vapor. Such a material will become saturated with condensed steam, and will then provide on its inner face a condensing surface on which further steam will condense, and on its outer face a surface from which water will evaporate, so that a continuous transfer of water will take place through the saturated material by condensation on the inner face and simultaneuos evaporation on the outer. It is thus the water which is the real vehicle for the transfer, while the

(Concluded on page 392)

EXHIBITORS AT THE FOURTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

Abbé Engineering Company.
Abbé, Paul O.
Ainsworth & Sons, Wm.
Air Reduction Company.
Alberene Stone Company.
American Aniline Products Company, Inc.
American Blaugas Corporation.
American-Ceramic Society.
American Chemical Manufacturing Company.
American Chemical Society.
American Cyanamid Company.
American Dyestuff Reporter.
American Electrochemical Society.
American Institute of Chemical Enginers.
American Kron Scale Company.
American La France Fire Engine Company, Inc.
American Leadburning Company.
American Metal Company, Ltd.
American Meter Company.
American Pipe Bending Machinery Company.
American Scientific Instrument Company.
American Steel Package Company.
American Transformer Company.
American Water Softener Company.
Anaconda Copper Mining Company.
Angel, H. Reeve & Company, Inc.
Aniline Dyes & Chemicals Company.
Anti-Hydro Waterproofing Company.
Apex Chemical Company.
Arnold, Hoffman & Company, Inc.
Arkell Safety Bag Company.

Bachmeier & Company.
Baker, J. T., Chemical Company.
Baltimore Cooperage Company.
Barber Asphalt Paving Company.
Bario Metal Corporation.
Barrett Company.
Bary de, Albert, Jr.
Bausch & Lomb Optical Company.
Bayonne Casting Company.
Beach-Russ Company.
Becker, Christian, Inc.
Beckley Perforating Company.
Bethlehem Foundry & Machine Company.
Bound Brook Chemical Company.
Boyer Oil Company, Inc.
Boyer Oil Manufacturing Company.
Bristol Company, The.
Brown Instrument Company.
Buffalo Foundry & Machine Company.
Butterworth-Judson Corporation.
Byers, A. M., Company.

Calco Chemical Company.
Campbell, John, & Company.
Canada Carbide Company.
Canadian Chemical Journal.
Canadian Electro Products Company.
Canadian Electrode Company.
Carborundum Company.
Carrier Engineering Corporation.
Celite Products Company.
Celluloid Zapon Company.
Central Dyestuff & Color Company.
Central Scientific Company.
Ceylon Company, The
Chemical Catalog Company, Inc.
Chemical Color & Oil Daily.
Chemical Company of America.
Chemical Construction Company.
Chemical Engineer, The.
Chemical & Metallurgical Engineering.
Chemical Pump & Valve Company.
Chemical Warfare Service.
Chile Copper Company.
Chile Exploration Company.
Chromos Chemical Company, Inc.
Clinchfield Products Corporation.
Color Trade Journal.
Consolidated Color & Chemical Company.
Consumers Dyewood Products Company.
Contact Process Company.
Corning Glass Works.
Crandall, Pettee Company.
Crane Company.
Crane Packing Company.
Crescent Color & Chemical Company.
Crescent Ink & Color Company.

Day, J. H., Company.
De Laval Separator Company.
Denver Fire Clay Company.
Department of Agriculture—Bureau of Chemistry.
Detroit Range Boiler Company.
Devine, J. P., Company.
Diamond State Fibre Company.
Dorr Company, The.
Dow Chemical Company.
Drackett, P. W., & Sons.
Du Pont Chemical Works.
Du Pont, E. I., de Nemours & Company—Wilmington.
Du Pont, E. I., de Nemours & Company—Arlington Works.
Du Pont Fabrikoid Company.
Duriron Castings Company.
Dye Products & Chemical Company.

Edison International Corporation.
Electro Bleaching Gas Company.
Electrolytic Engineering Corporation.
Electrolytic Zinc Company.
Electron Chemical Company.
Elmore, G. H.
Elyria Enameled Products Company.
Empire Chemical Company.
Empire Laboratory Supply Company.
Everlasting Valve Company.

Fleisher, W. L., & Company, Inc.
Foote Mineral Company.
Foxboro Company, Inc., The.
Fuller Lehigh Company.

Garrigues, Chas. F., Company.
General Bakelite Company.
General Bauxite Corporation.
General Ceramics Company.
General Chemical Company.
General Electric Company.
General Filtration Company.
General Fire Extinguisher Company.
Georgia Chamber of Commerce.
Georgia Mineral Products Company.
Georgia Potash & Chemical Company.
Glens Falls Machine Works.
Gordon Engineering Company.
Greiner, Emily, Company.
Groch Centrifugal Flotation Company.
Guernsey Earthenware Company.

Hanovia Chemical & Manufacturing Company.
Hardinge Conical Mill Company.
Harrison Works.
Hauser-Stander Tank Company.
Haynes Stellite Company.
Hayward, S. F., Company.
Heald, John H., Company, Inc.
Hemingway, Frank, Inc.
Hepworth, S. S., Company.
Hellenic Chemical & Color Company.
Hercules Engineering Company.
Hercules Powder Company—Chemical Sales Department.
Herold China & Pottery Company.
Hodges Water Still Company, Inc.
Holly Pneumatic Systems.
Hood, B. Miffin, Brick Company.
Hooker Electrochemical Company.
Hoskins Manufacturing Company.
Huff Electrostatic Separator Company.
Hunter Dry Kiln Company.
Huyck, F. C., & Sons.

Imperial Color Works.
Imperial Dyewood Company, Inc.
Independent Chemical Company.
Industrial Filtration Corporation.
Innis, Speiden & Company.
Irving National Bank.
Isco Bantz Company.
Isco Chemical Company.

Jacques Wolf & Company.
Janney, Steinmetz & Company.
Jewell Polar Company.
Journal of Industrial & Engineering Chemistry.

Kalbfleisch Corporation.
Kalbperry Corporation.
Kewaunee Manufacturing Company.
Keystone Minerals Company.
King Chemical Company.
Klipstein, A., & Company.
Knight, Maurice A.
Knoxville Board of Commerce.
Koppers, H., Company.

Leeds & Northrup Company.
Life Savings Devices Company.
Little, Arthur D., Inc.
Lummus, Walter E., Company, The.
Lungwitz, Emil.
Luzerne Rubber Company.

Macbeth-Evans Glass Company.
Machinery Utilities Company.
Manufacturers Record.
Marden, Orth & Hastings Company, Inc.
Mathieson Alkali Works, Inc.—Niagara Branch.
Mathieson Alkali Works, Inc.
Maynard, T. Poole, Ph.D.
Maywald, Frederick, F. C. S.
Meek Oven Manufacturing Company.
Mendelson Corporation.
Merck & Company.
Metals Disintegrating Company, Inc.
Metz, H. A.
Mine & Smelter Supply Company.
Miner-Edgar Company.
Monarch Manufacturing Works, Inc.
Monongehela Valley Traction Company.
Mott, J. L., Iron Works.
Moulton Engineering Corporation.
Multi Metal Separating Screen Company.

Nash Engineering Company.
Nassau Valve & Pump Corporation.
National Aniline & Chemical Company.
National Color & Chemical Company.
National Glue & Gelatine Company.
National Gum & Mica Company.
New Jersey Zinc Company.
Newport Chemical Works, Inc.
New York Commercial.
New York Revolving Elevator Company.

Niagara Alkali Company.
Niagara Electro Chemical Company
Nichols Copper Company.
Nitrogen Products Company.
Norton Company.

Obex Company.
Oil, Paint & Drug Reporter.
Oliver Continuous Filter Company.
Ontario Bureau of Mines.
Organic Salt & Acid Company.

Page Steel & Wire Company.
Palo Company.
Parks, G. M., Company.
Peerless Color Company.
Penn. Salt Manufacturing Company.
Pfaudler Company.
Philadelphia Quartz Company.
Philadelphia Textile Machinery Company.
Pneumercator Company, Inc.
Powdered Coal Engineering & Equipment Company.
Pratt Engineering & Machinery Company.
Precision Instrument Company.
Precision Thermometer & Instrument Company.
Process Engineers, Ltd.
Product Sales Company.
Provost Engineering Company.

Quigley Furnace Specialties Company.

Raritan Copper Works.
Raymond Bros. Impact Pulverizer Company.
Rector Chemical Company.
Republic Chemical Company.
Research Corporation.
Roessler & Hasslacher Chemical Company.
Rolling Chemical Company.
Rossendale-Reddaway Belting & Hose Company.
Ruggles-Coles Engineering Company.
R. U. V. Company, Inc., The.

Schaeffer & Budenberg Manufacturing Company.
Schaum & Uhlinger, Inc.
Schutte & Koerting Company.
Schwartz Sectional System.
Scientific Equipment Company.
Scott, Ernest, & Company.
Semet-Solvay Company.
Seydel Manufacturing Company.
Sharples Specialty Company.
Shawinigan Electro Metal Company.
Shawinigan, T., & Company.
Shriver, T., & Company.
Sidio Company of America, Inc.
Simmons, John, Company.
Solvay Process Company.
Southern Pine Association.
Southern Ball Clay Company.
Sowers Manufacturing Company.
Sparks, John C.
Stamford Extract Manufacturing Company.
Standard Emarex Company.
Stevens-Aylsworth Company.
Stauffer Chemical Company.
Stein, Hall & Company.
Sterling Color Company.
Stokes, F. J., Machine Company.
Stresen-Reuter & Hancock Company.
Stuart & Peterson Company.
Sturtevant Mill Company.
Swenson Evaporator Company.

Tagliabue, C. J., Manufacturing Company.
Takamine Laboratory, Inc.
Tank Equipment Company.
Taylor Instrument Companies.
Textile Colorist.
Textileather Company.
Textile World Journal.
Thermal Syndicate, Ltd.
Thermo Electric Instrument Company.
Thwing Instrument Company.
Tolhurst Machine Works.
Trades Reporting Bureau, Inc.

Uehling Instrument Company.
Union Dye & Chemical Corporation.
United Filters Corporation.
United Lead Company.
U. S. Cast Iron Pipe & Foundry Company.
U. S. Industrial Alcohol Company.
U. S. Industrial Chemical Company.
Universal Oil Company.

Valley Iron Works.
Van Dyk & Company.
Van Emden, H., & Company.

Wallace & Tiernan Company, Inc.
Warner Chemical Company, Inc.
Warner Klipstein Chemical Company.
Werner & Pfleiderer Company.
Westinghouse Electric & Manufacturing Company.
Whitall Tatum Company.
Williamsburg Chemical Company.

Zapon Leather Cloth Company.
Zaremba Company.
Zavon, Inc.

Texas Sulphur Company.

Plans are being made by the recently organized Texas Sulphur Company, Orange, Texas, to install the oven system of extracting sulphur as used in Sicily for countries. The company was chartered with a capital of $500,000. A. C. Fleig is president and A. C. McFarlane is vice-president.

Recovery of Light Oils

(*Concluded from page 376*)

This liquid passes upward through a tank containing a solution of caustic soda. By this process any sulphonated olefines which remain in the toluol are removed. Otherwise they would be broken up in the column still and have a destructive action on the dephlegmator and condenser. The condenser coil and connections of this intermediate still should be made of lead.

The final distillates are considered as substantially pure materials if their specific gravities also agree with those which have been determined for the pure constituents. If, however, the specific gravity is lower than that of the pure benzol or toluol it is indication of the presence of paraffins, and to a certain extent the lowering is a measure of the amount of paraffins present.

It is understood that there is no commerically feasible way of separating these paraffins; and in the case of toluol, if the amount exceeds two per cent. the toluol is unfit for the manufacture of explosives. It is stated by some operators that by regulating the speed of distillation it is sometimes possible to make the paraffins distil into other than the toluol fraction, even when present in excess in the crude toluol; but the real remedy is to adjust the gas-making conditions so that the paraffins will not be produced. It is evident that special knowledge and skill are necessary from beginning to end of the recovery process.

Organic Symbols

(*Concluded on page 378*)

the direction of the clock-hand movement when the compound is *LEVO*-rotatory, and in the reverse direction when the compound is *DEXTRO*-rotatory. In inactive compounds the direction of the tails will balance: Compare e.g. dextro, levo-lactic-acid, dextro-levo-glycericacid in *Figure 2* and d- and l-leucine in *Figure* 5.

(b) in *HETEROCYCLIC* compounds a dot outside the lines indicate the heterocyclic atom (either O, N or S) thus differentiating better homocyclic from heterocyclic compounds.

Tautomeric forms, which express themselves mainly in a different arrangement of the double bonds, are very clearly indicated by the symbols and an arrow pointing both ways indicates the equilibrium. Thus compare e.g Phloroglucin and uric acid in *Figure* 5.

Trans- and cis-types of compounds are illustrated in *Figure 2* by maleic and fumaric acid.

The field of organic chemistry is so vast that it is difficult to select a few cases, but I hope that with the help of the figures the idea of *ORGANIC SYMBOLS* is conveyed sufficiently to recognize the importance of such a system.

Berkeley, July 1, 1918.

Ultra Violet Light

(*Concluded from page 386*)

below the lines which they accompany. There appears to be no connection between the mechanisms which produce the D-lines and the visible channeled spectra on the one hand and the ultra violet double lines on the other. The evidence seems to show that the different lines of the Balmer series and their accompanying channeled spectra are produced by different entities, and it is suggested that these are atoms which have lost one, two, three, four, etc., electrons. *Bevan* (Phil. Mag., 1910 (iv), 19, 195) has found that the principal series lines of potassium appear in much greater numbers in the absorption spectrum of potassium vapor than in any form of emission spectrum which has yet been examined. The method of experiment consisted in heating potassium in a steel tube, the ends of which were closed by quartz plates. A beam of light was passed through the tube, and the emergent beam was examined by means of a quartz spectrograph.

Salicylic Acid Vapor

(*Concluded from page 388*)

canvas or other substance serves as a support for the water.

An advantage arising from the method is that the resulting crystals, being condensed in a chamber entirely free of all traces of iron or other metals which in the ordinary water-cooled metal condensers are likely to contaminate and spoil them, are free of all such impurities. Further, the crystals thus produced are comparatively dry owing to the escape of the steam through the walls of the condenser, and to the retention of any condensed steam in the canvas walls crystals obtained are so dry as to contain only 1 per cent of moisture, and consequently not requiring any further treatment beyond the application of very gentle heat, thus preserving the natural crystalline formation, and avoiding further risk of contamination.

Chemical Plant Near Completion.

Work will soon be completed on the new addition to the plant of the Valley Chemical Co., La Salle, Ill. Production will probably be started within the next three months.

Pyrotol Chemical Co.

Chemical and kindred products will be manufactured by the recently incorporated Pyrotol Chemical Co., Beaumont, Texas. The capital of the new concern is $35,000 and the incorporators are, Bruce Richardson, S. Gordon, E. J. Goodier and A. H. Safir.

"Indefilco" Presses Office Comes Home.

The Independent Filter Press Co., Inc., announces the removal of their office from 47 W. 34th St., New York City, to 418 Third Ave., Brooklyn, N. Y. This move is expected to speed up production, as factories and office will now be under one roof. A. Couttrell will supervise the manufacturing end of the business.

Foreign Trade Opportunities

Further information can be obtained by addressing the U. S. Bureau of Foreign and Domestic Commerce, Washington, D. C. Write each application on separate sheet.

Oleomargarin

26599.—An agency is desired by a man in Switzerland for the sale of lards, butter, *oleomargarin and substitutes*, and allied products; also rosin. Correspondence may be in English. Reference.

Chemical Products

27047.—A man in France desires to purchase *chemical products* and drugs. Quotations may be made f. o. b. New York. Payment will be made against documents. Correspondence should be in French Reference.

Paints, Colors and Matches

27069.—A man in the United States who is representing a firm in England desires to purchase and secure an agency for the sale of piece goods, hardware, iron products, all kinds of machinery, *paints, colors, matches*, buttons and laces. References.

Chemical Products

26593.—A man in Spain desires to secure an agency for the sale of general merchandise, including *chemical* and pharmaceutical *products*. Correspondence should be in Spanish. References.

Tanning and Dyeing Materials

27109.—An agency is desired by a man in Italy for the sale of medicines, drugs, *tannery and dye materials*, colonial goods, and oil seeds. Catalogues, samples, and price lists should be submitted. Correspondence may be in English. Reference.

Metals and Chemicals

27044.—The American representatives of a firm in Norway desire to secure an agency for the sale of foodstuffs, *chemicals, metals*, raw materials, and general merchandise of every description. Quotations should be made f. o. b. New York. Payment will be made against shipping documents and established credit in New York.

Caustic Soda Crystals

26920.—A man in Venezuela desires to receive cable quotations on 300 drums of 350 kilos each of *crystallized caustic soda*, 78 per cent grade. The price should be made f. o. b. New York delivery. Payment will be made in New York against shipping documents.

Various Leathers

26914.—A firm in Switzerland desires to purchase all kinds of *leathers*, such as waxed and flexible splits, glaced kids, hemlock and oak sole leather, harness leather, and saddlery, and motor-car leathers. Quotations should be made f. o. b. Boston or New York.

Masek Co. Adds to Plant.

The contract has been awarded by the Masek Glue Co., 908 Denison Ave., Cleveland, Ohio, for the erection of a one-story 30x60 foot glue factory. The cost is estimated at $40,000.

American Ingraft Co.

With a capital of $25,000 the American Ingraft Co., Inc., has been incorporated under the laws of New York to manufacture chemicals, etc. The principal incorporator named is Morris Yedlin.

To Manufacture Paper.

Paper and paper products will be manufactured by the firm of S. Walter, Inc., Philadelphia, Pa., which was recently incorporated with a capital of $75,000. Harry Lefkowitz is the principal incorporator.

Pyodine Chemical Co.

With a capital of $25,000 the Pyodine Chemical Co. has been incorporated at Los Angeles, Cal., to manufacture chemicals, etc. The incorporators are Dr. David Osterhold, E. Osterhold and Fred B. Osterhold.

HELP WANTED

PRACTICAL EXPERT wanted in manufacture of food products; one knows how get results from raw materials; give experience, reference, etc. C., c/o Chemical Engineer.

MECHANICAL AND CHEMICAL ENGINEER—A manufacturer wants a man with above qualifications to help develop his present method of production; state detail experience, age, and salary expected. Write Engineer, Room 611, World Building, New York City.

WANTED, ANALYTICAL CHEMIST FOR FERTILIZER FACTORY. A fine opportunity for an energetic and ambitious young chemist understanding machinery and with knowledge of heat engineering and practical chemistry. Write "V. C.," c/o Chemical Engineer.

WANTED—Chemist; female, analytical and research. Apply during business hours, or phone Ossining 1057 for an interview. Ossining Chemical Works, Ossining, N. Y.

WANTED—Organic Chemist, of high caliber; must have had experience in research, plant design and plant operation, a man of character and ambition required, who can qualify for responsible position in growing organization within thirty miles of New York City. Initial salary up to five thousand, depending on qualifications. State nationality and necessary details, which will be held in strict confidence. Box J. C., c/o Chemical Engineer.

CHEMIST for position as factory manager; must have thorough training in chemical engineering; draft exempt; best of references required; good salary with excellent chances for advancement. Apply Mangano Manufacturing Co., 17 Seminary Ave., Rahway, N. J.

Will Mine for Phosphates.

The Armour Fertilizer Works, Chicago, are planning the erection of a $150,000 plant for the mining of phosphates near Columbia, Tenn.

ANALYTICAL AND CONSULTING CHEMIST
MATERIALS ANALYZED—RESEARCH WORK.
FACTORY PROCESSES INVESTIGATED.
FRED'K J. AUSTIN, 119 Nassau St., N. Y. C.

CHEMICAL MAGAZINES
BACK COPIES OF DOMESTIC AND FOREIGN PERIODICALS FOR SALE. WE BUY SETS, VOLUMES, AND NUMBERS.
B. LOGIN and SON
152 EAST 23rd STREET, NEW YORK CITY

Glass Cloth—Glass Wool
and everything in the line of spun glass.

The glass cloth made entirely of glass, or with wire or silk warp, which we are now manufacturing, can be used for all insulation purposes; storage batteries, etc., etc.; where fireproof articles are required, such as curtains, draperies, hangings for hotels, theatres and public places; for diffusing light in moving picture studios, etc., etc.; for filtering and straining acids, etc.

Inquire at once about this new product and its application to your work.

L. REUSCHE & CO. 12 Barclay Street
NEW YORK CITY

CHEMICALS
COLORS
MINERALS

For the following Trades:

RUBBER OIL CLOTH
PAINT PAPER
TEXTILE PRINTING INK
POTTERY LEATHER

KATZENBACH & BULLOCK CO.
New York Trenton Chicago
Boston San Francisco

NEW PUBLICATIONS

Copper

A new publication issued by the U. S. Bureau of Standards, Circular No. 73, is entitled "Copper."

This circular deals primarily with the physical properties of pure and of commercial grades of copper. The best data and values are given for the various physical characteristics and constants, together with a bibliography of the sources from which these values were taken. The effect of impurities upon the properties of copper is dicussed as well as the influence of various factors in its manufacture, and altogether the circular should be of great interest to every one concerned with the production of this metal, and altogether the circular should be of great interest to everyone concerned with the production of this metal.

This paper is now ready for distribution and those interested may obtain a copy by addressing a request to the Bureau.

Photoelectric Sensitivity of Bismuthinite

A new publication of the Bureau of Standards, Scientific Paper 322, is entitled "The Photoelectric Sensitivity of Bismuthinite and Various Other Substances."

This paper summarizes the results of an investigation of various substances (1) for an increase in electrical conductivity caused by the action of light upon them, and (2) for photoelectrical activity when they were charged to a negative potential, in an evacuated chamber and exposed to light.

Of the various substances examined, none were found which are as sensitive to light as the selenium cell, and the potassium photoelectric cell.

Experiments are described in which some of these substances are used as photophones.

This paper is now ready for distribution and those interested may obtain a free copy by addressing a request to the Bureau.

Thermal Expansion of Alpha and of Beta Brass

A new publication of the Bureau of Standards. Scientific Paper No. 321, is entitled "Thermal Expansion of Alpha and of Beta Brass."

The Bureau has been investigating, recently, the failure of brass articles, rods, bolts, etc., by crack-

BECKMANNS
THERMOMETERS
NORMAL, ALLIHN'S & ANSCHUTZ
Gottwik, Scheffer & Co.
25 Church Street, NEW YORK
HYDROMETERS
CALORIMETER

ing. Instances have been observed in which cracking occurred in brass articles which had been quickly cooled from a forging or annealing temperature by quenching or otherwise, and it was considered possible that this may have been due to the development of local stresses in the brass during such cooling. The present study was made with a view to ascertaining the approximate magnitude of the local stresses which might be set up in heterogeneous brasses of the type Muntz metal, and the effect of such stresses upon the mechanical properties of this metal.

This paper is ready for distribution and those interested may obtain a free copy by addressing a request to the Bureau.

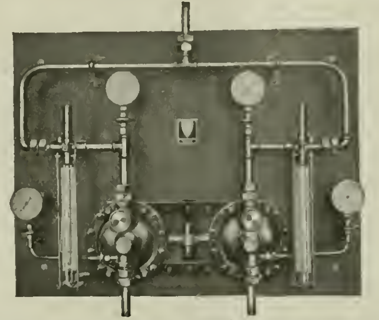
"Effect of the Size of Grog in Fire-Clay Bodies"

A new publication of the Bureau of Standards, Technologic paper 104, is entitled "Effect of the Size of Grog in Fire-Clay Bodies."

The size of grain has long been known to exert considerable influence upon the properties of mortars, concrete, fire clay refractories, and other materials. The present investigation determines the effect of the size of the calcined portion, or grog, upon the properties of fire clay bodies within a field of practical sizes. The general plan of procedure consisted of separating grog into a number of sizes, recombining these in arbitrary proportions by calculation from triaxial diagrams, mixing with an equal weight of clay, and molding with water into test pieces for raw state, as indicated by the modulus of rupture, depended upon a number of factors and did not vary directly with the size of grog. Proper proportions of grog sizes gave stronger bodies than single grog sizes. The strength of burned bodies increased directly with decrease of the size of grog, the size being expressed numerically as a surface factor. Bodies containing the large sizes were more resistent to sudden heating and cooling from 600° C. and 1000° C. Volume shrinkage in burning to cone 12 increased approxi-

(*Concluded on page* 398)

The Control of Gases



We are specialists in the control, measurement, application and proportioning of gases. The cut above shows one type of equipment developed to combine in predetermined proportion two gases of totally different properties.

W & T EQUIPMENT
For Gas Control

is constructed with the same care and attention to minute detail that has distinguished "W & T" Chlorine Control Apparatus for Water and Sewage Purification.

Our Engineering Staff is prepared for Consultation on problems of Gas Control.

Wallace & Tiernan Co., Inc.
137 Centre Street
New York City

C. L. PARKER
Chemical Patents
TRADE-MARKS
UNFAIR COMPETITION
McGill Building, Washington, D. C.

McCormack & Company
Chemists and Chemical
ENGINEERS

Analytical and Consulting Chemists

We enjoy making the unusual chemical analyses such as most chemists do not like to bother with.

We have at our disposal the best equipped laboratories in this country for the study of chemical manufacturing processes and problems.

OFFICE and LABORATORIES
33rd and Armour Avenue
CHICAGO Phone Douglas 390

New Jersey Testing Laboratories

Operate extensive experimental plant for trying out new processes on the large scale. Special arrangements made for the demonstration and commercial development of chemical products and processes.

92-98 Greenwood Avenue MONTCLAIR, N. J.

ACME TANKS

ANY SIZE OR SPECIFICATION

Three factories, situated in the East, Middle West and Pacific Coast, enable us to give you special service in the manufacture of tanks.

We have on hand reserve supplies of air-dried woods suited for the different chemical requirements, making prompt shipments possible.

Our many years' experience in handling tanks to standard and special specifications should be of value to you. Your specifications will have our immediate and careful attention.

ACME TANK COMPANY
37 Cortlandt Street, New York City Telephone: Cortlandt 2520

TO CHEMISTS

whether they wear the uniform of the C. W. S., or are serving their country in some other way, and to manufacturers concerned with the advancement of our Chemical Industries, the necessity for ridding ourselves once and for all of the threatened German military and commercial domination needs no explaining.

The FOURTH LIBERTY LOAN

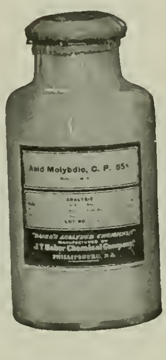
is a means to that end

Our war expenses are increasing at the rate of $100,000,000 a month. The Government is in urgent need of money to make your future welfare safe. Because of what you have at stake, it is doubly your duty to support this Loan to the limit of your resources. This is no time to deliberate!

Don't wait for solicitations

BUY YOUR BONDS EARLY

On Your Next Chemical Order—



SPECIFY

"Baker's Analyzed"
Chemicals and Acids

After a trial you will specify them on ALL your orders, because you will find them dependable reagents of the highest quality and uniformity.

An Accurate Analysis Appears on the Label of Each Bottle

Catalog on Request

J. T. BAKER CHEMICAL CO.
PHILLIPSBURG, N. J.

Size of Grog

(*Continued from page 395*)

mately with decrease of porosity in the dry or burned states. Methods are suggested for proper proportioning of grog for glass pots, saggers, and similar bodies.

This paper is now ready for distribution and those interested may obtain a free copy by addressing a request to the Bureau.

National Aniline Will Add to Plant.

The National Aniline & Chemical Co. has plans under way for the construction of a six-story reinforced concrete brick and steel factory addition to their Buffalo plant. The estimated cost is $300,000.

DESIGNS FOR CHEMICAL BUILDINGS
AND COMPLETE EQUIPMENTS
MILL ENGINEER
Frank Sutton
80 BROADWAY, N. Y. C.
Established 1897 Tel. Rector 960

The Reed Laboratories
RESEARCH AND ANALYTICAL
SPECIALIZING IN LEATHER
TANNING AND DYEING MATERIAL
227 Fulton Street, New York, N. Y.

Hugo Mock *Asher Blum*
Mock & Blum
PATENTS AND TRADE MARKS
CHEMICAL PATENTS A SPECIALTY
220 BROADWAY
NEW YORK CITY

RICHE' ADIABATIC CALORIMETER
Renders exact determinations of caloric and combustion contents. Sold by first class dealers of laboratory supplies. We will gladly send catalog.
We also manufacture light machinery, interchangeable parts, stampings, etc., on special order.
Merit Machine Manufacturing Corporation
465 Greenwich Street, New York

B. JURIST, Chemical Director
Formerly with N. Y. Dept. of Health PHONE: BARCLAY 6987
Research Laboratories, Incorporated
19 PARK PLACE, NEW YORK
CONSULTING and ANALYTICAL CHEMISTS
CONSULTING SANITARIANS
CHEMICAL and BACTERIOLOGICAL EXAMINATIONS
SANITARY and INDUSTRIAL INVESTIGATIONS

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

Any commercial product reproduced.

FOR
MANUFACTURERS
AND CHEMISTS

ALL questions, materials for analysis, or letters leading to the opening of negotiations for special chemical research work, will receive prompt attention if addressed to—

DR. CHARLES B. DAVIS
169 West 152nd Street
New York City

Chemically Pure

LABORATORY REAGENTS

Chemically Pure

ACIDS

Hydrochloric Acid, sp. gr. 1.19
Sulphuric Acid, sp. gr. 1.84
Nitric Acid, sp. gr. 1.42
Acetic Acid, 99.5%

Ammonia Water

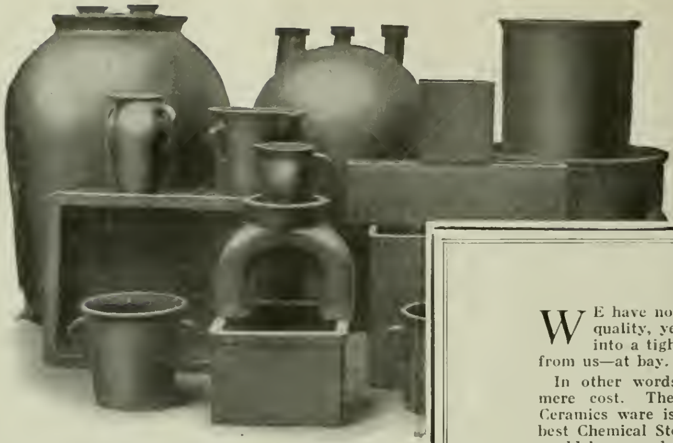
sp. gr. 0.90

WE manufacture and carry in stock a full line of Chemically Pure analytical reagents. These reagents do not require preliminary testing, and the results obtained by their use are accurate.

Our Products will be furnished by the leading Supply Houses, if B. & A. Chemicals are specified on orders.

LIST FURNISHED ON REQUEST

The
Baker & Adamson Chemical Company
EASTON, PENNA.



WE have no corner on Chemical Stoneware quality, yet we have it cornered—backed into a tight place where it can't get away from us—at bay.

In other words, we have put the kibosh on mere cost. The price you pay for General Ceramics ware is fair price, based on the very best Chemical Stoneware that anyone in all the world has ever been able to make.

That's what you get when you order G. C. Ware. You also get prompt action, and in case your order is large, you are enabled to draw upon the enormous facilities of our big plant.

General Ceramics Company
50 Church St., New York City

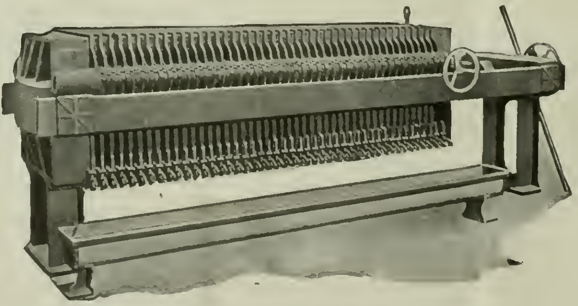
Western Sales Office: 112 W. Adams St., Chicago

See our exhibit at the Fourth National Exposition of Chemical Industries, Grand Central Palace, week of September 23rd.

Cornered!

Shriver Filter Presses

FOR ALL PURPOSES



SIDE FEED FILTER PRESS

FILTER PRESS PUMPS

FILTER CLOTH AND PAPER

SEND FOR CATALOG "B"

T. SHRIVER & COMPANY

Office and Works: 812 Hamilton Street HARRISON, NEW JERSEY

C.P.N
CHEMICAL CO.
Covers the Country
"We Serve and Save"

EXCLUSIVE SALES AGENTS FOR

NEVIN CHEMICAL CO.

St. Louis, Mo.

MANUFACTURERS OF

Barium Binoxide
Barium Oxide
Barium Sulphide
Barium Nitrate
Barium Carbonate
Barium Chloride
Barium Sulphate, Dry and Pulp
Sodium Sulphide 60/62
Sodium Nitrite 99%
Sodium Nitrate Ref.

C P N CHEMICAL CO., Inc.

Department O

Industrial Chemicals

80 Reade St.
New York

227 W. Huron St.
Chicago

Chemical Bldg.
St. Louis, Mo.

Rector Chemical Co., Inc.

Office, 2 Rector St.,
NEW YORK CITY

Manufacturers of

METOL (Rector)
PARA AMIDO PHENOL
HYDROCHLORIDE

and other photographic chemicals and intermediates.

Distributors of

PARA NITRO PHENOL
ORTHO NITRO PHENOL
PHTHALIC ANHYDRIDE
PARAPHENYLENEDIAMINE

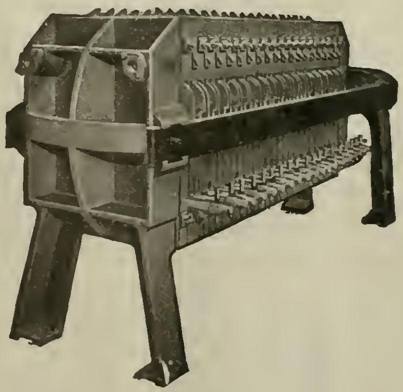
and other chemicals.

15,000 "Johnson" Filter Presses

NOW IN USE

The "Johnson" Diaphragm Pump

All Types, All Sizes
Made of
Iron, Bronze, Lead, Aluminum,
Tin and Wood,
also
Belt, Steam and Electrically
Driven
Filter Press Pumps
and
Turbine Mixers



Backed by Forty Years' Experience

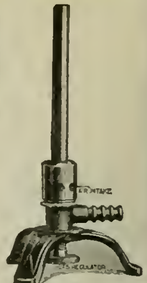
John Johnson Company

37th Street and Second Avenue, Brooklyn, N. Y.

OXYGEN

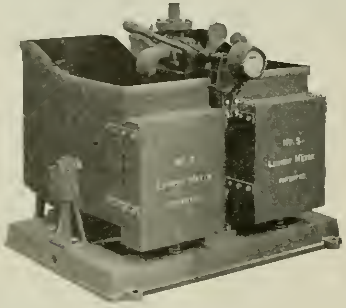
TO FILL PRESENT NEEDS WE ARE SUPPLYING OXYGEN IN LOW PRESSURE TANKS TO ACCOMMODATE THE TRADE WHO DO NOT REQUIRE LARGE QUANTITIES OF GAS IN ONE SHIPMENT.

BESELER OXYGEN CO.
131-133 E. 23rd St., N. Y. C.



Gas for—
laboratory and industrial uses
—automatically made
by the
Detroit Combination Gas Machine
Descriptive catalogue and names of users in your vicinity sent on request.
Detroit Heating & Lighting Co.
616 Wight Street, Detroit, Mich.
Established 1868

"Detroit"
Laboratory Burner



"MORE THAN A METER"

The Improved Leinert Automatic Liquid Gravity Scales
(PATENTED)

A Simple-Positive Mechanical Balance for Recording by Weight. Recommended for WATER—JUICES—BRINE—CAUSTIC SOLUTIONS and LIQUIDS of all descriptions.

Not Affected by Temperature Changes or Variations in Specific Gravity. Special Scales to Meet Your Requirements. WRITE US YOUR SERVICE CONDITIONS.

JOHN SIMMONS COMPANY
107-111 Centre Street :: New York City

H. A. METZ & CO., Inc.
122 HUDSON STREET, NEW YORK

BOSTON PHILADELPHIA SAN FRANCISCO ATLANTA
PROVIDENCE CHICAGO CHARLOTTE

PRODUCTS:
Dyestuffs, Colors, Intermediates, Sizing and Finishing Materials

Dyestuffs, Colors, Sizing and Finishing Materials *Produced by* Consolidated Color and Chemical Co. Newark, N. J.

Dyestuffs and Intermediates *Produced by* Central Dyestuff and Chemical Co. Newark, N. J.

New Jersey
zinc

The world's standard for Zinc products

WE manufacture zinc products exclusively. We own and operate our own mines and plants. Our experience covers a period of seventy years. Every detail of manufacture is carried out under the personal direction of expert operators.

That is why New Jersey Zinc Dust is a dependable product. By a special process, perfected within our organization, we are able to produce dust of greater uniformity and unvarying high quality.

We also manufacture Zinc Oxide, Spelter, Rolled Zinc Strips and Plates, Zinc Chloride, Lithopone, Spiegeleisen and Sulphuric Acid in all concentrations.

THE NEW JERSEY ZINC COMPANY
55 Wall Street, New York
ESTABLISHED 1848
Chicago: Mineral Point Zinc Company
1111 Marquette Building

TABLE OF CONTENTS

Editorial 407

Chemical Show Proves Year's Progress 408

The Fourth National Exposition of Chemical Industries held in the Grand Central Palace is here dealt with from the point of view of importance as an indication of the progress made during the past year by American chemists and manufacturers.

Thousands of Chemists Visit Exposition 410

A collection of personal items about some of the visitors to the Grand Central Palace during the Exposition.

Chemists Describe Industries' Growth 411

Abstracts of some of the more important papers read at the conferences held during Exposition week by gatherings of chemists and manufacturers interested in many branches of industrial chemistry.

Shawinigan Hopes to Rival Niagara District .. 413

By J. Herbert Hodgins, Manager Statistical Department Union Bank of Canada, New York City.

The recent establishment of a U. S. Government-owned plant at Shawinigan Falls, Canada, has drawn attention to the interesting electrochemical development at this plant.

German Manufacturers Using New Cellulose Yarn 415

Reports from Germany indicate that under the stresses of a raw material shortage, German chemists and manufacturers have evolved a cellulose yarn derived from wood pulp.

Cross Index of Chemical Terms 416

By Elton R. Darling.

This index was prepared as an aid in ascertaining the true chemical names of various substances.

Artificial Silk Chemists' Triumph 417

By Louis K. Hirschberg, M.A., M.D.

The story of the development of artificial silk with a brief but exhaustive description of the various methods of manufacture.

Tariff Commission Chemist Sees Bright Future 419

Grinnell Jones, Chemist to the United States Tariff Commission, reviews before the American Chemical Society the recent development of the American chemical industries and deals with its future prospects.

An Artist's Impressions of the Chemical Show 420

Time for Changed Educational Policy 423

Prof. William Johnston Pope, President of the Chemical Society of Great Britain, pleads for a changed attitude towards the chemist on the part of the educator and the business man.

A New Aniline Black with a Titanium Base 427

By Elton R. Darling.

A new dye which by the elimination of vegetable dyes makes it possible to dye fast blacks without injuring the tensile strength of textiles.

New Publications 434

Foreign Trade Opportunities 438

Largest American Producers of

Army Khaki
for Cotton and Wool

Blues
for Navy Cloth

Diphenylamine
Dimethylaniline
Aniline Oil
Dinitrophenol
Monochlorbenzol
for Explosives

National Aniline & Chemical Company
Incorporated
Main Sales Office: 21 Burling Slip, New York

BRANCHES:

Boston
Charlotte
Chicago
Cincinnati
Hartford
Kansas City
Milwaukee
Minneapolis
Philadelphia

Back up the Boys in France—Buy W. S. S. regularly

THE CHEMICAL ENGINEER

Copyright, 1918, by McCready Publishing Company

VOL. XXVI. OCTOBER, 1918 No. 11

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

ALEXANDER G. SCLATER,
Editor.
CHARLES B. DAVIS, F. C. S., Consulting Editor
H. C. DAYCH, Business Manager

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

OCTOBER, 1918

IF there was anyone who, after a visit to the Fourth Chemical Exposition in the Grand Central Palace during the week of September 23, was still disinclined to question the time-honored fable of Germany's pre-eminence in the field of industrial chemistry, a reading of either the speech of the president of the British Chemical Society, published elsewhere in this issue, or of the article published in a recent number of the *Economic World*, entitled "The Myth of Germany's Pre-Eminence in Chemistry," should effect a cure. In both cases it is clearly shown that, first of all, the coal tar color industry owes its origin to British chemists, that very few of the useful elements were discovered by Germans, and furthermore that, although until the beginning of the war, Germany had made more of the coal tar color industry than any other nation, since the outbreak of the war, American chemists and manufacturers have made greater progress in the production of dyes than Germany ever did in the same period.

So far as the mineral chemical industries are concerned America, even before the war, could stand comparison with Germany or any other country. In fact, when it comes to the production of acids and heavy chemicals, we are, in many branches, decidedly ahead of the Teutons.

THE regrettable disaster at the Gillespie shell loading plant in New Jersey has again drawn public attention most forcibly to the dangers that exist in war time for those even three thousand miles away from the front line trenches. While no cause has been yet assigned by those investigating the explosion, it is to be hoped that both the investigators and the public in considering the placing of responsibility will remember the wise words of Dr. W. G. Hudson, medical director of the Dupont Company, in a recent paper entitled "Safeguards in the Manufacture of Explosives," "If explosives like dynamite, smokeless powder and TNT were made only by skilled chemists under the best of laboratory conditions, they would seldom, if ever, cause explosion accidents. . . . But when these substances are produced in the immense quantities required by present conditions, ordinary labor must be used, and many of these men are unskilled and have no speaking knowledge of English. However careful our chemists, supervisors and foremen may be, it is difficult to guard against someone of these thousands becoming careless at times and, of course, the results of an explosion are visited upon all in the vicinity."

IN the light of the present fuel shortage, the recent meeting of the American Peat Society was of particular interest. Several scientists of note, pointed out in the course of the meeting ways and means whereby the nation's peat bogs could be made immediately available.

While it is hardly likely that in the midst of war anything will be done either in the United States or elsewhere to make the world's immense peat resources of use to industry, it can, however, be safely predicted that with the close of the war the attention of chemists in all parts of the world will be directed towards the very important problem of making peat available as a competitor of coal. The successful solution of this problem, bringing as it will, immense fields within the reach of not only industry, but the private consumer as well, will solve many a sociological and manufacturing problem. It will perhaps eliminate to a certain extent one very prolific cause of war—the international controversies over the possession of coal fields.

In Great Britain a great deal of experimentation has already been done and considerable success has been experienced in making an easily handled and very marketable peat fuel. The success met with by the English chemists and scientists is no doubt an indication of what may be done in the not far distant future by other nations.

The decision of the Advisory Committee of the National Exposition of Chemical Industries, to hold the next Exposition in Chicago, cannot help but stimulate public interest in the chemical industries of the Mid-West.

Chemical Show Proves Year's Progress

Exhibits at Fourth Annual Chemical Exposition Give Clear Indication of Great Strides Made by American Industrial Chemistry During Past Year—Attendance Greater Than Ever Before.

AMERICA had another answer to fling back at Germany during the week of September 23rd. This time the answer came from the chemists of the United States and was delivered in the form of the Fourth National Exposition of Chemical Industries at Grand Central Palace, in New York, which, literally interpreted, declared that America has, within the short period of several years, freed itself from the predominance of German chemistry. The imperative war time needs of this country for chemicals that, previous to 1914, we were solely dependent upon Germany for providing, have been met as a result of the activities of our own chemists and scientists. This the recent exposition at New York very strikingly demonstrated.

In all respects the Fourth National Exposition of Chemical Industries was a success far beyond the most sanguine expectations of those interested in its promotion. It graphically illustrated the marked strides that the American chemist has made during the past few years; it showed the generous and unselfish co-operation that the chemist as an individual and the chemical industry in its entirety have extended to the Government in the promotion of its war activities. The record-breaking attendance that marked the exposition proved the closer relationship that now exists between the American public and the American chemist. The display also brought into contact the banker, the manufacturer, the business men and the chemist.

The New York display was truly a war-time exposition of America's chemical and chemical manufacturing achievements in furthering the Government's war making activities. For this reason the exposition probably exceeded in importance, and in its broad relation to the nation's welfare, any similar industrial exposition held in the world, due to the fact that chemistry, in a greater or less degree, enters into every industry and is playing a deciding part in gas warfare.

Practically every branch of chemistry and allied lines was represented, the exhibits covering, among others, dyestuff manufacture, the by-products of coal and coke and iron and cement, pharmaceutical chemistry and apparatus, biological chemistry, and machinery ranging from the simplest appliance to a complete plant for intricate processes; copper and other metals, aniline products, enamels, synthetic dyes and colors, corks, asphalt, lenses, foundry products, engineering apparatus, porcelains, etc.

During the last year great strides have been made in the industries based on chemistry. Among the latest achievements the country is now producing potash from several sources, and as a by-product in the manufacture of iron and cement. It has developed and improved the manufacture of light metals for airplanes, heavy metals for every purpose, dyes, soda and bleaching powder, lenses, special pottery, excessive heat-resisting utensils, etc.

E. G. RIPPEL
The presiding genius of the imposing exhibit of the Buffalo Foundry & *nows this and has made it*

The Government Exhibits

The Governments of Canada and the United States were represented at the show, the Canadian Government presenting the materials it has available for development by the chemists and the financiers. The United States Government, through its Gas Offense Division, had an interesting exhibit of incendiary bombs, gas shells and gas bombs. After viewing this exhibit one had a full realization of what the chemists have accomplished in perfecting methods of offense and defense in gas warfare.

"For display that ordinarily would be considered solely as a scientific show, the attendance was truly remarkable," stated Dr. C. H. Herty, chairman of the Exposition Advisory Committee, at the close of the exposition. "It emphasized one outstanding feature, that the war has created a keener interest on the part of the general public in the development of war necessities and the part that chemistry plays in their production. Likewise, it has created a closer relationship between the American public and the chemist. As an educational display the exposition ranked high, for even the most

W. H. HENDRICKS,
Chief Sales Engineer o
the New Jersey Zinc Co.
doesn't sell zinc product
all the time.

DR. EMIL LUNGWITZ, Outside of selling Kelly Filter presses, likes nothing better than a stein of (censored) and a few cigarettes.

casual visitor in the Palace could obtain a liberal education by a survey of the exhibits. To many business men the exposition provided an opportunity to discover some methods of utilizing or profitably disposing of some by-product of their business which heretofore had been discarded. It brought all trades and professions together for the interchange of ideas. Generally speaking, it was a huge success."

Coal Conservation Illustrated

A new angle to the Garfield fuel conservation orders was provided by an immense display board showing samples of the various products derived from coal. To the average person coal is considered simply in the light of fuel, but a study of the display board at the Palace disclosed the fact that no less than 212 products are derived from this mineral. These products range from the heavy coal tar to the light liquid perfumes and paints.

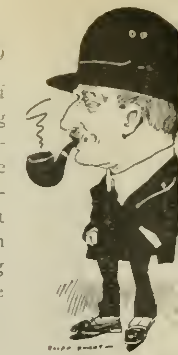
The Chemical Exposition afforded a most striking demonstration to the advanced position of the American chemical industry in answering the dye and drug situation. Scarcely two years have elapsed since many lines of our industrial life were threatened with utter demoralization because of the shortage of dyestuffs and medicinals resulting from the blockade of German ports by the British navy. Textile mills faced imminent possibilities of shutting down because of the inability to secure dyestuffs for the fabrics. Tanners, lithographers and wall paper men sought in vain for needed coloring matter, and pharmacists' stocks of many much-needed medicinals became depleted. On account of these shortages and the accompanying speculation in the remaining stocks, prices soared to undreamed of heights.

F. F. UEHLING, Of the Uehling Instrument Company, "hits it up" occasionally along the country roads.

The exposition showed that within this short period of two years, one of which had been devoted to war preparations, a miracle has been wrought. All lines of industrial life which formerly depended upon imports are now operating under normal conditions, and in addition we are now shipping large quantities of these former imported products to foreign countries.

The Development of Ceramics

America's development of its ceramic industries during the past few years to the position where the United States is now absolutely independent of Germany and Austria for supplies of its firebrick, pottery, glass, etc., was clearly shown at the Chemical Exposition. The ceramic branch of the chemical industry is daily gaining in importance. At the beginning of the war but little optical glass was being manufactured in this country. The necessity of the war brought together the manufacturers and scientific and technical organizations with the result that the developments in this field have been truly remarkable. The most interesting advancements in the glass industry have been those relating to the optical, colored (signal) and the resistant or chemical glasses, which heretofore were produced chiefly by Germany.



DR. W. LEINER
Of the Leinert E
neering Co., was ca
by the artist loo
over his exhibit

The Chemical Exposition was a growing illustration of the advantage to our industries which chemistry has afforded. The growth of our industries of all kinds has been greatly assisted by chemists. Strictly speaking, all industries are chemical industries, but some industries are more obviously chemical industries than others. This exposition had to do naturally more with the industries which are obviously chemical, but the general proposition that all industries are dependent upon chemical processes should be emphasized, even if, in each case, the connection is not obvious to the unthinking man. This war has taught us that all industry is more or less chemical in its character.

Industry Doing Its Part

What the great chemical industry in this country is doing to produce the big Allied victory, what America has accomplished in taking the enormous chemical, glass and dye industries away from Germany—and taking them permanently—was demonstrated most decisively at the Exposition. Most potent were the wonderful ramifications of this basic industry demonstrated. While no high explosives or poison gas was exhibited, owing to their dangerous nature, the processes by which they are obtained and manufactured was illustrated by machinery exhibits, large and small, and by motion pictures. Naturally, the side of chemistry which is related to munitions was most interesting to the general public. Gas masks and their operation, bombs, high explosive shells, etc., loomed importantly in the layman's mind, but equally important were the wonderful new industrial chemical and electrochemical processes and inventions operated on a most gigantic scale since the United States went to war—operated on a scale never even conceived in peace times.

Next Show in Chicago

In conjunction with the exposition the annual conventions of several chemical and technical organizations were held. These conventions brought many chemical engineers and experts to New York City for the first time since the present great development of the chemical business in this war as a result of the cutting off of imports of chemicals and dyestuffs from Germany and other foreign countries since the beginning of the war.

Thousands of Chemists Visit Grand Central Palace

An immense number of out of town visitors inspected the various exhibits during the week. Not the least interested from out of town points were C. H. Kimberly, of Philadelphia; P. H. Walsh, of the Dominion Textile Company, of Montreal, Canada; Dr. Richard Moldenke, of Watching, N. J.; Dr. C. G. Derrick and Dr. W. H. Watkins, of Buffalo, members of the National Aniline and Chemical Co.'s Buffalo staff, and Dr. C. K. S. Mees, of the Eastman Kodak Co., Rochester.

Instead of conducting groups of Pratt Institute students around the Exposition, as in former years, this time Major Rogers was kept busy behind the booth of the Chemical Warfare Service to which the sometime professor has been attached since May.

E. Haefel, chief of the laboratories of the Robert Gair Company, Brooklyn, in spite of the fact that he is a very busy man these days, managed to spend a few hours during the week looking over the exhibits, and meeting the many friends from all parts of the country, he found at the Exposition.

R. L. Vilas, assistant sales manager of the Dupont Chemical Works, was in charge of the Dupont Company's fine exhibit.

Not all of Mr. Vilas many friends in the industry know that in addition to being an engineer of sales of no small ability, he is a member of the American Society of Magicians, of which Harry Houdini, the "handcuff king" is president.

Dr. Arthur D. Little, of Arthur D. Little Inc., spent several days at the Exposition, presiding over the potash symposium Wednesday afternoon.

Dr. W. R. Whitney, research director of the General Electric Company and a member of the Naval Consulting Board, visited the Exposition during the week and spent a number of very profitable hours visiting the various exhibits.

A certain contemporary described Corporal Charles F. Roth, of the Chemical Warfare Service, one of the joint managers of the Exposition, as a "modest, gentle-spoken soul." Some of those who have encountered the corporal in his energetic moods would, perhaps, be inclined to question this characterization.

A great number of the men most prominent in the ceramics industry of the United States visited the Exposition during the week. L. E. Barringer, chairman of the special committee of the American Ceramic Society appointed to arrange the meeting of the society held during the course of the Exposition, led the van.

A number of very much interested visitors from overseas dropped into the Grand Central Palace during the course of the Exposition. Major J. H. Brightman, British attache of the Chemical Warfare Service, made a very thorough-going tour of the Palace during the week and expressed himself as being very much interested.

Dr. Bernard C. Hesse, of the General Chemical Company, a man who has taken a leading part in the revision of the available American chemical statistics, was a frequent visitor to the Exposition during the week.

Ensign D. Delahanty, who is now engaged in doing airplane research work as a member of the personnel of the naval air service, at Rockaway Naval Air Station, visited the booth of the Chemical Engineer early in the week.

Many Interesting Exhibits at Show

A tour of the exhibits in the Grand Central Palace during the Fourth Chemical Exposition was a liberal education to either the layman or the more sophisticated technical man; the layman came to see that chemistry and its allied processes played a larger part in the body industrial than he had ever thought, and the technical man was able to discover what his brother chemists had succeeded in doing during the year just past.

In its old place on the ground floor the exhibit of the Buffalo Foundry and Machine Company, in point of dignity and impressiveness probably exceeded most of the other exhibits at the Exposition. The central feature of this exhibit was a gigantic 5,000-gallon nitrator, which, by the courtesy of a customer, the company was permitted to show at the exposition. Such is the demand for the company's products, that all the chemical apparatus shown were taken from the company's experimental laboratories. The exhibit was in charge of E. G. Rippel, the sales manager of the Buffalo Foundry and Machine Company.

A veritable romance of chemistry was epitomised in the Dupont exhibit to the north of the entrance on the ground floor. The wealth of industrial materials derived from coal tar bases was visualized for the visitor to the Exposition in a most illuminating and interesting way. After looking at this exhibit the visitor came to the conclusion that having contributed materially towards the demolition of the German war lords the Dupont Company was now preparing to demolish the German commercial barons. In making this exhibit of their dyestuff products the Dupont Company sought to emphasize the importance of the corporation's achievement in erecting in the space of ten short months a plant capable of turning out enough synthetic indigo to supply the total needs of the United States.

In these days when coal conservation is one of the big problems of the day among manufacturers, the booth of the Uehling Instrument Company, featuring the firm's coal economizing devices, attracted a great many visitors. Those in charge of the booth said that the company had all it could do these days keeping up with its orders.

The wide range of apparatus for the conduct of chemical warfare in its various phases, exhibited on the second floor, by the Chemical Warfare Service of the United States Army under the direction of Major E. F. Briethut, until recently a professor at the College of the City of New York, was throughout the exposition the centre of attention. Gas masks, gas shells and grenades of various nations were shown and both chemist and non-technical men were enabled to appreciate to some extent the part the chemist was playing in the actual fighting of Uncle Sam's battles.

Speaking of dyestuffs, the exhibit of the National Aniline and Chemical Company, featured the company's two latest achievements: The production of two fast colors for which the textile trade has been waiting, Alizarene Sapphire and Carbanthrene Blue. Alizarine Sapphire is the fastest known level acid dye to light for wool and Carbanthrene Blue a vat dye of the greatest fastness to washing for cotton.

There were a whole series of bull's eyes on the products exhibited by the New Jersey Zinc Company, indicating that the company has been fighting the Huns in its own way. There was a bull's eye on their drawn zinc rod and wire and another on zinc oxide U. S. P., now being made for the first time in this country in large quantities.

Industries Grow Under War's Stimulus

Representatives of Chemical Industries and Allied Enterprises Emphasize Great Progress Made by All Branches, in Speeches Delivered at Conferences Held During Chemical Exposition.

During the course of the conferences held on the third floor of the Grand Central Palace during exposition week a great many papers were read and speeches delivered dealing with various aspects of the development of the chemical industries of the United States since the outbreak of war in 1914. Taken as a whole these messages from chemists in all parts of the country, interested in half a dozen different branches of industrial chemistry, enabled those fortunate enough to attend the conferences to appreciate to some extent not only the problems the chemists of the country faced in 1914, but enabled them to appreciate the gigantic proportions of the industries at the present time. For the benefit of those who were prevented from attending all or any of these conferences the following abstracts of some of the papers read are printed.

C. KINGSBURY,
ngineer of the Gen-
amics Co., “looking
natural.”

That there has been a nine hundred per cent. increase in the manufacture of nitric acid in the United States since the war began in 1914, was the statement made by E. L. Pranke, in the course of a paper read before the conference held on the afternoon of the 24th. Incidental to this vast increase in the volume of acid manufactured, there had been an equally great increase in the efficiency of the manufacturing methods, an increase which was typified according to the writer by the introduction of such improvements as the substitution of modern fire boxes provided with proper “arch” for the Dutch ovens, the replacing of the chemical stoneware from the retorts to the condensers, and the glass condenser tubes by acid-proof, high-silica iron, and the replacing of the ordinary form of rings in the towers by the spiral ring.

In 1914, 78,589 tons of nitric acid of ordinary strength had been produced, according to the census of the manufacturers and 112,124 tons of mixed acids. According to other data given in the census these figures represented about 89,000 tons of 100 per cent nitric acid. All of this acid had been produced from nitrate of soda consuming about 160,000 tons of nitrate. The pre-war importation of nitrate amounted to about 560,000 tons of nitrate per annum, hence the normal consumption of nitrate for other purposes than the manufacture of nitric acid was about 400,000 tons.

The present rate of importation, the writer said, was about 1,600,000 tons of nitrate per annum. Mr. Pranke estimated that about 1,000,000 tons of nitrate is now being converted into nitric acid. This was equivalent to 650,000 tons of 100 per cent. nitric acid of which nearly five-sixth is being used for the manufacture of military explosives.

Yet greater developments were predicted for the future by Mr. Pranke. The nitric producing rate in the spring of 1919 would be about 650,000 tons from nitrate of soda and about 225,000 tons by oxidation of ammonia from the air, a total of 475,000 tons of 100 per cent. nitric acid or about nine times the pre-war normal consumption.

While Mr. Pranke predicted further development of the nitric acid manufacturing industry he warned those present at the conference that with the coming of peace, over four-fifths of the acid producing capacity will have to be shut off from the decrease in demand.

Touching upon the improvements that had been made in acid making plants since the beginning of the war, Mr. Pranke said that important changes in equipment and operation, such as the increasing of the charge of nitrate from 5,000 to 7,500 pounds per retort, the operation of the retorts in rotation instead of in batches as formerly, and the substitution of two for three runs a day per retort, had resulted in a decided increase in the amount of nitrogen recovered as acid from an average of about 78 to 80 per cent. to about 92 to 94 per cent. of the nitrogen in the nitrate of soda.

So far as the development of new methods was concerned since the outbreak of the war in 1914, Mr. Pranke emphasized the great strides made by the ammonia oxidation industry. He felt that the successful development of the ammonia oxidation process justified to a certain extent the belief that it would be the principal source of nitric acid in the future. The differential between ammonia gas and sulphate of ammonia would make a difference in favor of ammonia oxidation of from 15 to 20 per cent.

Utilization of Sawdust.

George H. Tomlinson, of Niagara Falls, Canada, in a paper dealing with the utilization of wood waste as a source of ethyl alcohol, said that if the millions of tons of wood waste annually produced in the United States were to be made use of, in the production of alcohol, a radical change must be made in the methods used by those who are seeking to develop the industry.

There were a number of reasons why, in Mr. Tomlinson's opinion the industry centering about the manufacture of ethyl alcohol from wood waste had not developed as rapidly as its possibilities justified. The industry, he believed had been injured to a great extent by the fact that many of the promoters of companies, formed to engage in the manufacture of alcohol from wood waste, had been more interested in the formation of the companies than they had in the development of the industry itself. Adequate research had not in many cases preceded the location and the building of the plants, and plants had been located and built in many cases without due consideration having been given to the commercial conditions involved.

It had been originally assumed, the speaker said, that every sawmill represented a possible location for the establishment of an ethyl alcohol plant. It was further assumed that since there were innumerable sawmills where the disposition of sawdust was a serious problem, that this material could be bought in large quantities at a merely nominal figure. In making these assumptions the early promoters of the industry had overlooked the fact that although there were undoubtedly immense quantities of sawdust turned out by the mills in all parts of the country, there were few at which the conditions were entirely favorable for the establishment of the extensive plant which the manufacture of ethyl alcohol requires. They forgot also that there were a number of other factors, beside the supply of raw material, to be taken into consideration, such as the water supply, the labor supply and the question of transportation.

Electrochemistry and War

The important part the electrochemist has played in assisting the Administration in its war work was emphasized by F. J. Tone, president of the American Electrochemical Society, in an address made during the afternoon of the opening day of the Exposition.

The chemical industry of the United States has made great strides during the past four years, Mr. Tone said, and no small part of this advance had been due to the part played by electrochemistry in the industrial processes of the country.

"America has long enjoyed a supremacy in electrochemistry, but in spite of the strong position of the industry before the war no one would have dared to predict the expansion which the war would demand of us," said Mr. Tone in the course of his speech. "It has called for chlorine, cynamide, air nitrates and phosphorus in vast quantities. It has required the ferro alloy industry, the electrode industry and the abrasive industry to quadruple their outputs."

While the electrochemical industry as a whole had nobly met the demands made upon it by the nation's war needs, it was imperative Mr. Tone insisted that they remember that their war work is only begun. If this war was a chemists' war, the peace that would come after it would be a chemists' peace. When peace came no one would have a better opportunity to serve his fellow man than the chemist. For with them rested the solution of the problems involved in the conservation and proper utilization of our resources, the elimination of wastes, the problems of foodstuffs, clothing and sanitation.

Making of Pyrophoric Alloys

The manufacture of pyrophoric-alloys or "sparking metals" from the by-products of the Welsbach gas mantle manufacturing industry was described in detail by Dr. Alcan Hirsch, in a paper entitled, "The American Pyrophoric Alloys Industry," during the afternoon of the 27th.

Most of the thoria used in the manufacture of Welsbach mantles was now derived from monazite sand, Dr. Hirsch said. In the United States about a quarter of a million pounds of throium oxide was annually produced from over five million pounds of monazite sand. The by-products of this process contained more than a million pounds of the "cerium oxides" annually. These oxides constitute the raw material of the American pyrophoric alloy industry.

The cerium metals are reduced in an electric furnace by electrolyzing their molten salts. The metal so obtained after being alloyed with about thirty per cent. of other metals, is formed into small "flints" to be used in lighters, igniters, mechanical fuses and other similar devices.

The Chemist and Industry

"The general proposition that all industry is more or less dependent upon chemistry should be emphasized, even if the connection in each case is not obvious to the unthinking man," said G. W. Thompson, president of the American Institute of Chemical Engineers, at the conference held on the opening day of the exposition. "We learn by adversity. This war has taught us that all industry is more or less chemical in its character . . . and we, seeing the extent to which chemistry could be of service to the nation, have learned a lesson, although our education in this direction is not complete."

Mr. Thompson appealed to those who controlled manufacturing processes to learn more fully the need of chemical knowledge for the perfection of industry. In addition the speaker said that the colleges and universities must learn that however valuable pure chemistry might be as a study or as a means of mental discipline the most important thing that chemistry does is in its application. Chemists, too, he said, must learn more fully and completely the need of applying their knowledge to chemical processes conducted on a large scale.

"Manufacturers," continued Mr. Thompson, "can do a great deal to help the universities and colleges in developing more efficient methods of instruction. They can do this by calling university and college professors into their councils and developing the practical side of these professors so that the students will be developed along lines which will be useful to industry.

"Practical business men often distrust college professors. They say that they are theoretical and visionary. This in many cases is due to the fact that the practical business man has a narrow vision. Sometimes it may be true that the instructors in chemistry have not a practical turn of mind. Whether this view of business men is true or not the remedy lies in their own hands, and if they will see their broad duty they will throw open their plants more freely to instructors in chemistry and make the education of chemists a part of their organized plan. In other ways our colleges and universities must be used by our manufacturers, and our manufacturing plants must be opened to use by our universities and colleges."

"To assure the industries of the United States permanent chemical independence," said Dr. Charles H. Herty, chairman of the Advisory Committee, in formally declaring the exposition open on the afternoon of the 23d, "there must be brought about the closest possible cooperation."

(Continued on page 432)

Shawinigan Hopes to Rival Niagara District

Granting of Big Contract for Acid to Canadian Electrochemical Company Draws Attention to Developments and Future of Industries Located in Northern Quebec.

By J. HERBERT HODGINS,
Manager Statistical Department, Union Bank of Canada, New York City.

THE recent announcement that the Shawinigan Water and Power Company, of Shawinigan Falls, Quebec, Canada, had been given the contract to erect and operate a plant for the manufacture of acetic acid for the United States Government, has served to indicate in a most emphatic way to American chemists and manufacturers a changing balance of power in the American electrochemical industries, a changing alignment of forces presaged for some time past by the questioning of the supremacy of the Niagara Falls district as the centre of the electrochemical industries of the continent. This impression was rendered more emphatic by the statement made incidental to the announcement of the granting of the contract, that the step had been taken because, in the opinion of the authorities at Washington, the Shawinigan Water and Power Company was the only corporation on the continent possessing immediately available power resources to undertake the manufacture of acetic acid in large quantities.

While the fact that the United States Government was willing to send the necessary funds to Canada to finance the enterprise was in itself significant of the relations existing between the United States and her northern neighbor, the fact possesses peculiar interest to those Americans, either chemists or manufacturers, interested in the development and future of the electrochemical industries of the continent.

This official recognition on the part of the United States Government of the claim made by the American capitalists, backers of the Shawinigan enterprises, indicates that those enterprises and industries centering about Shawinigan Falls represent the premier water power enterprise of the continent. This being the case, it is fairly safe to say that American capital, when aiming to locate and develop electrochemical industries, must continue to consider to an even greater extent than heretofore the vast resources possessed by her northern neighbor in accessible, but as yet, undeveloped water power.

The resources and the stage of development reached in the Shawinigan district should, therefore, prove not only interesting to the capitalist with industries to locate, but should particularly interest the chemist and manufacturer who already connected either directly or indirectly with one or other of the electrochemical industries, seeks to ascertain something of what the future holds for the electrochemical industries of the United States.

The Location of Development

The main developments of the Shawinigan Water and Power Company are located at Shawinigan Falls, midway between Montreal and Quebec City, the town deriving its name from an old Indian word indicating the resemblance between the aboriginal quill and bead work and the great falls of the St. Maurice River, the river where the town of Shawinigan stands.

Until 1898 Shawinigan, now a city of over 12,000 inhabitants, consisted of one house. But with the coming of the engineers of the original Shawinigan Falls Development Co., the formation of the Pittsburg Reduction Company and the building of the Canadian Northern Railway, the history of the city and the industries which rapidly sprang up about the Falls began. In this year the Legislature of the Province of Quebec granted the Shawinigan Water and Power Company a charter, giving it a wide range of power. The Provincial Government also sold the company all the property upon which the city now stands and handed over the water power on the St. Maurice River at this point. Thus the company came into possession of 11,000 acres of land and one of the greatest natural water powers in the world, a falls with a drop of 150 feet.

Falls Have Immense Power

Then came the development of the Falls. A canal or forebay was excavated from a point near the crest of the Falls, about a thousand feet west, the end of the canal being closed by a concrete wall, in which were placed headgates and entrances to penstocks. These penstocks conducted the water from the forebay walls through their length of 450 feet to the power stations at the lower level. This canal has a depth of 20 feet at low water and at its narrowest point has a width of 100 feet. It is capable of developing 150,000 horse power.

The first electric installation consisted of two 5,000 horse power water wheels and generators. Gradually thereafter the plant was enlarged to utilize the capacity of the hydraulic works until the installation in No. 1 station reached the amount of 55,500 horse power.

At Shawinigan Falls the Shawinigan Water and Power Company now has in operation four power houses with a capacity of 196,000 horse power. The latest house of this development has five 20,000 horse power units and nine miles above Shawinigan there is yet another power house with an installed capacity of 120,000 horse power.

Company Keeps Eye on Future

The Shawinigan Company has had an eye to the future as well as the present, and has acquired water rights and other rights preliminary to the possible development of 75,000 horse power at the Gres Falls, four miles below Shawinigan. Here there is a head of 65 feet. In addition to this within one hundred miles there are other undeveloped water powers with a potential capacity of over 300,000 horse power. Totaling the present developed and possible power available, the immediately visible supply of power capable of being fed to the Shawinigan system amounts to 1,091,000 horse power, of which 550,000 is understood to be unsold.

The present developments of the company summarized come to this—there is now installed 511,000 horse power of generating machinery feeding the system. Forty thousand horse power is at present available for prompt delivery. About 580,000 horse power is yet undeveloped and this, with the horse power still unsold, makes 680,000 horse power available for the electrochemical industries located in the St. Maurice valley.

Of the electrochemical industries located in and about Shawinigan, the Northern Aluminum Company, formerly the Pittsburgh Reduction Company, was one of the first to locate on the St. Maurice. American refined bauxite is brought up by rail and reduced to aluminum. This company uses about 60,000 horse power for this purpose. The Northern Aluminum Company has also a wire and cable manufacturing plant and manufactures practically all the aluminum wire made in Canada.

Many Industries at Work

The Canada Carbide Company uses 40,000 horse power in manufacturing calcium carbide and acetylene gas.

The Shawinigan Electro Metals Company, another of the city's industries, produces metallic magnesium in many forms and sells the greater part of its product in Canada.

One of the largest industries in Shawinigan is represented by the plant of the Canadian Electro Products Company, a plant put into operation only since the beginning of the war. This company manufactures acetic acid and acetone from acetylene gas supplied by the Canada Carbide Company.

Another of Shawinigan's industries is the Prest-o-lite Company. This company operates an acetylene gas compressing plant, using gas supplied by the Canada Carbide Company.

The steel industries are represented by the experimental electric furnace plant of the Fraser Brace Company, where various types of steel are manufactured.

The Canadian Aloxite Company, a subsidiary of the Carborundum Company, is building an extensive plant covering about 15 acres and will make use of, it is expected, about 20,000 horse power.

The pulp and paper industry is represented by the plant of the Belgo-Canadian Pulp and Paper Company and the Laurentide Company, which respectively utilize 18,000 and 28,000 horse power.

A further development of the electrochemical industries of the district is represented by the plant of the Canadian Electrode Company. This company, as its name indicates, manufactures electrodes.

Even from such a cursory examination of the present development and the future possibilities of the Shawinigan district of Northern Quebec, it is apparent that the industries already developed and likely to be developed in this district in the near future are destined to play no mean part in the immediate future in the electrochemical industry of the continent.

Japanese Dye Factories

Japanese factories manufacturing dyestuffs now number more than one hundred, exclusive of a great many small ones turning out inferior goods, according to a recent issue of the Japan Advertiser. The same authority claims that the total investment in these hundred factories represents over $7,000,000. In spite, however, of the development of the Japanese dyestuff industry since the beginning of the war in Europe, the domestic market is still said to be dependent for its supplies upon importations from foreign countries A feeling is said to be evident among the more farsighted members of the dyestuff industry in Japan that without proper protection against foreign competition only a comparatively few of their number will be able to survive for any length of time the coming of peace. These men have persuaded the Government to undertake the investigation of proposals whereby a high tariff wall around the Empire to protect the Japanese industry.

The incorporation is announced from Albany of the Zenith Drug & Chemical Company, with an authorized capital of $5,000. The incorporators are W. I. Newman, E. C. Davidson and T. F. Thornton.

R. Pettinger, H. Brach and A. Regan, of 70 Fifth Avenue, Manhattan, are announced as the incorporators of the United States Emergency Ration Company, with an authorized capital of $100,000. The company's charter authorizes it to engage in the manufacture of foodstuffs and chemicals.

German Manufacturers Using New Cellulose Yarn

Reports from Germany Indicate that Under Stress of Raw Material Shortage Hundreds of Mills in Teutonic Countries Are Making Yarns of Wood Pulp.

REPORTS reaching this country from Germany by way of various neutral countries, serve to indicate that under the stress of the shortage of raw materials brought about by the allied blockade, German chemists and manufacturers have met with considerable success in their efforts to evolve a cellulose yarn from wood pulp. While the manufacturers of paper yarn met with little success in their attempts to obtain a suitable substitute for wool and cotton yarns, if all reports may be believed, a greater degree of success has been attained by those who have sought to make fibres derived directly from cellulose.

The progress made by German chemists and manufacturers in manufacturing a yarn from cellulose, out of which durable garments can and are being made, should prove of great interest to American chemists, not so much because of the implication of the fact that the people of Germany have reached such extremities that they are driven from lack of raw materials to seek such methods of clothing themselves, but also because it is not at all unlikely that for many years after the conclusion of peace, wool will be scarce and expensive, and because German manufacturers of textiles are already declaring their intention of manufacturing vast quantities of garments made from mixtures of cellulose fibre and cotton or wool for export to all parts of the world. If only to equip themselves against the effects of this threatened competition, American manufacturers will be compelled to keep in touch with the developments of this new industry which has sprung up in Germany.

That there exists in America an opportunity for an industry of a similar nature, there seems to be little reason to doubt. The manufacture of artificial silk from cellulose and similar materials has reached within the last few days vast dimensions, and there seems to be little reason why with a knowledge of the proper technique, a similar industry could not be built up around the production of fibres from wood pulp.

Writing in the *Frankfurter Zeitung*, the textile labor leader Kratzig, makes the following statement in regard to the process at present being tried out by some of the German textile manufacturers:

"For cellulon, the cellulose fibres are prepared in the same way as for paper manufacture, usually without addition of resin. The material is run over a revolving sieve, where it is cut into strips as the water runs off. These strips are then wound on bobbins and while still moist brought to the spinning machine. The paper yarn thus made is smoother and stronger than that made from strips. After the war paper yarn, no matter how made, will be used only for coarse materials, such as sacking. This new staple fiber is different. It is made after the material has been dissolved into a jelly-like mass. This mass is spun through a fine sieve which delivers very fine fibers. These fibers are spun into threads, which can be dyed any color. This yarn is not now washable, but great efforts are being made to find some method which will make it so. The material can, it is true, be washed but when moist it is weak and soft. It, however, regains its strength when dried. By mixing some cotton with the material, a cloth can be made which can be washed like pure cotton goods. If wool is mixed with it, it makes a fine cloth. This yarn can be woven on any kind of a loom."

The same man writing in the *Konfektionar,* another German publication, reveals the fact, that in spite of the progress made so far with this new fibre, efforts to improve it still further were being retarded at the time of writing by the indifference of the Government and the selfishness of the owners of the patents under which it is manufactured.

"The Government," he says, "should take the initiative to support the experiments for the improvement of this fiber. The textile industries have for months been applying to the Government for help to produce this fiber and nothing has been done. The reason for this inactivity on the part of the Government lies in the difficulties made by the corporation which exploits the patents. . . . If we go about this work systematically and take care that the fiber as well as the material produced from it is not subjected to the same price increases as the paper weaves were we can look forward to the future with confidence. If we make earnest efforts to utilize this fiber in the right way, we have nothing to fear from the economic war. As for the wool

Cross Index of Chemical Terms

Compiled by E. R. Darling.

THIS cross-index was prepared as an aid in finding true chemical names and other synonyms associated with them. Only those chemical compounds whose name does not indicate their true chemical terms are here listed.

Some general titles are:

"Butter" of a metal refers to the Chloride.
"Calcined" of a metal refers to the Oxide.
"Caustic" of a metl refers to the Hydroxide.
"Flowers" of a metal refers to the Oxide.
"Muriate" of a metal refers to the Chloride.
"Vitroliate" of a metal refers to the Sulfate.

Acid Cardonate of Potash—See Potassium Bicarbonate.
Acid Carbonate of Soda—See Sodium Bicarbonate.
Acid Potassium Sulfate—See Potassium Bisulfate.
Acid Potassium Tartrate—See Potassium Bitartrate.
Alabaster—See Calcium Sulfate.
Alum—See Potassium Aluminum Sulfate.
Alumen—See Potassium Aluminum Sulfate.
Alum Flour—See Potassium Aluminum Sulfate.
Alum Meal—See Potassium Aluminum Sulfate.
Alumina—See Aluminum Oxide.
Aluminite—See Potassium Aluminum Sulfate.
Alumini Ustum—See Dried Potassium Aluminum Sulfate.
Amido Chloride of Mercury—See Ammonium Mercuric Chloride.
Ammoniated Mercury—See Ammonium Mercuric Chloride.
Ammonio-Chloride of Mercury—See Ammonium Mercuric Chloride.
Anglisite—See Lead Sulfate.
Anhydride of Antimony—See Antimony Trioxide.
Anhydrous Arsenic Acid—See Arsenic Oxide.
Anhydrous Arsenious Acid—Arsenious Oxide.
Anhydrous Arsenicosm—See Arenious Oxide.
Anhydrous Calcium Sulfate—See Dried Calcium Sulfate.
Anhydrous Chromic Acid—See Chromic Trioxide.
Antimony Black—See Antimony Sulfide.
Antimony Bloom—See Antimony Trioxide.
Antimony Grauce—See Antimony Trisulfide.
Antimony Red—See Antimony Pentasulfide.
Antimony Vermilion—See Antimony Trisulfide.
Antichlor—See Sodium Thiosulfate.
Aqua Calcis—See Calcium Hydroxide
Aragonite—See Calcium Carbonate.
Arsenic—See Arsenious Oxide.
Arsenic Anhydride—See Arsenic Oxide.
Arsenic Blanc—See Arsenious Oxide.
Arsenic Orange—See Arsenic Trisulfide.
Arsenic Yellow—See Arsenic Trisulfide.
Arsenious Acid—See Arsenious Oxide.
Arsenious Anhydride—See Arsenious Oxide.
Asbolite—See Cobalt Oxide.

Barite—See Barium Sulfate.
Baryta—See Barium Oxide.
Barytes—See Barium Oxide.
Badic Carbonate of Magnesium—See Magnesium Carbonate.
Bichloride of Mercury—See Mercuric Chloride.
Bihydrate of Lime—See Dried Calcium Sulfate.
Biniodide of Mercury—See Mercuric Iodide.
Binoxide of Lead—See Lead Dioxide.
Binoxide of Manganese—See Manganese Dioxide.
Bismuth Yellow—See Bismuth Trioxide.
Bismuth White—See Basic Bismuth Nitrate.
Bismutite—See Basic Bismuth Carbonate.
Bitter Salts—See Potassium Chloride, also Magnesium Sulfate.
Blanc Fixe—See Barium Sulfate.
Black Lead—See Lead Dioxide.
Black Oxide of Cobalt—See Cobalt Oxide.
Black Oxide of Copper—See Cupric Oxide.
Bleaching Powder—See Calcium Hypochlorite.
Black Mercury—See Ammonium Mercurous Chloride.
Black Precipitate—See Ammonium Mercurous Chloride.
Black Oxide of Mercury—See Mercuric Oxide.
Blue Coppras—See Copper Sulfate.
Blue Salts—See Nickel Sulfate.
Blue Stone—See Copper Sulfate.
Blue Vitriol—See Copper Sulfate.
Bone Ash—See Calcium Phosfate.
Bone Earth—See Calcium Phosfate.
Brilliant Scarlet—See Mercuric Iodide.
Brown Acetate—See Calcium Acetate.
Brown Lead Oxide—See Lead Oxide.
Butter of Antimony—See Antimony Chloride.
Butter of Arsenic—See Arsenic Chloride.
Butter of Cadmium—See Cadmium Chloride.
Butter of Chrome—See Chromium Chloride.
Butter of Cobalt—See Cobalt Chloride.
Butter of Silver—See Silver Chloride.
Butter of iZnc—See Zinc Chloride.
Burnt Alum—See Dried Potassium Aluminum Sulfate.
Burnt Lime—See Calcium Oxide.

Cadmium Yellow—See Cadmium Sulfide.
Cake Alum—See Aluminum Sulfate.
Calcite—See Calcium Carbonate.
Calcined Gypsum—See Dried Calcium Sulfate.
Calcined Magnesium—See Megnesium Oxide.
Calcined Mercury—See Mercuric Oxide.
Calcined Plaster—See Dried Calcium Sulfate.
Calomel—See Mercurous Chloride.
Calomelas—See Mercurous Chloride.
Calx Chloride—See Calcium Hypochlorite.
Calx Chlorinata—See Calcium Hypochlorite.
Calx Chlorate—See Calcium Hypochlorite.

(Continued on page 434)

Artificial Silk Chemists' Triumph

Industry's Central Chemical Problem of To-day Is to Produce Fiber Possessing Even Greater Tensile Strength and Pliability—Industry Has Interesting History.

By LEONARD KEENE HIRSHBERG, A.B., M.A., M.D.

ACCORDING to Mr. C. Ainsworth Mitchell, the manufacture of the products known as "artificial silk" affords a striking instance of a successful superficial imitation of a natural substance.

The idea of producing by mechanical means fine fibres which would possess the luster and other characteristics of silk and be strong enough to be woven into fabrics is by no means new, although it is only within the last twenty years or so that any degree of commercial success has rewarded the attempts made in this direction.

As far back as 1734 it was suggested by the French naturalist Reamur that since silk was to be regarded as a naturally hardened "gum" it might be possible to produce similar lustrous fibres by forcing some varnish, such as that used by the Chinese, through minute openings, and drying the filaments thus obtained. But this idea was not followed up and it was not until after the lapse of a hundred and twenty years that any practical attempts to produce such artificial fibres appear to have been made.

In 1855 a patent was taken out in England by Andemais for the manufacture of fine threads from cellulose. The fibres from the bark of mulberry trees were converted into an inflammable compound and dissolved in a mixture of alcohol and ether, as in the early "wet plate" process in photography, and the solution mixed with a solution of indiarubber. A steel point was dipped in the viscous solution and the threads adhering to it when removed were drawn out as finely as possible by means of a winding machine and left to dry.

The Mechanical Problem Involved.

The invention may be regarded as the parent of many of the successful processes of the present day, most of which are based upon dissolving cellulose or its compounds in some suitable solvent, and passing the solution through fine openings so as to form filaments which remain in a flexible form on removal of the solvent by evaporation or otherwise. The problem which has been more or less satisfactorily solved in these processes is, in the main, a mechanical rather than a chemical one, for it is not owing to any difference in chemical composition but to a difference in physical structure that silk possesses a lustre which ordinary cotton lacks.

There are in fact, numerous vegetable fibres which resemble cotton in chemical composition but have a silken lustre owing to their possessing a surface like that of silk. Thus the seed hairs of the plane Eriodendeon anfractinosum closely resemble silk in appearance, and certain varieties of cotton have fibres of such a form that they are much more lustrous than the more common kinds. This difference is so pronounced that long before the invention of artificial silk, seed cotton was sometimes used as a silk substitute, its natural lustre being increased by singeing off the fine hairs upon the surface or by rolling.

Making Vegetable Fibres Silky.

Simple treatment with certain chemical agents is also sufficient to alter the surface of certain non-lustrous fibres in such a way that they reflect the light, or in other words, become lustrous. A familiar example of this is seen in the mercerization of cotton in which under the combined influence of caustic alkali and of tension the characteristic flattened twisted fibres become straightened into more or less cylindrical tubes having a high degree of lustre. In like manner a silken lustre may be imparted to jute fibre by immersing it for a short time in a strong solution of caustic soda, and then washing it with soda.

But in such cases as these there is only an alteration in existing fibres, which still remain much coarser than those of natural silk, whereas in the artificial products the fibres are constructed from the beginning and in some of the best preparations are but slightly thicker than those of genuine silk.

This stage of excellence has taken long to reach, mainly owing to the mechanical difficulties of producing fibres of such fineness. After the publication of the Andemais patent nothing further was heard of the production of an "artificial silk" until 1883, in which year Mr. J. W. Swan patented a method of obtaining threads from a solution of nitro-cellulose in acetic acid or other solvent, forced through small openings and subsequently rendered non-explosive by treatment with ammonium sulphide or other deoxidizing agent. These fibres were intended primarily for use in the manufacture of mantles for incandescent gas-burners, but are described in the patent as "artificial silk," and were used experimentally in the weaving of textiles.

The Beginning of the Industry.

Two years later Count Chardannet took out his first patent, the chemical principle of which was similar to that of Swan's patent, and this may be regarded as the beginning of the industry.

In Chardannet's process cotton or wood pulp is converted into nitro-cellulose, which is dissolved under pressure in a mixture of alcohol and ether so as to yield a viscous solution. This is conducted through pipes into a series of troughs in the spinning room, each trough ending in a small glass jet 1/100 millimetre in diameter. The filaments forced through these "silk-worms," as they are called, were formerly delivered under water, but better results are now obtained by a process of dry spinning, in which the solvent is made to evaporate. Four, six or more filaments are spun together, and the threads pass through ammonium sulphide solution to denitrate them, with the result that they are rendered non-explosive and even less inflammable than ordinary spun cotton. Finally the silk is dyed to any color required.

The methods of du Vivcei and of Libner in 1889 are very similar to the Chardannet process. In the former the nitrocellulose is dissolved in glacial acetic acid and the solution mixed with solutions of gutta percha in carbon bisulphide and fish glue in acetic acid, before being passed through the minute orifices; while in the latter the nitro-cellulose solution is incorporated with a solution of silk waste, and the fine filaments precipitated by means of water.

Many Other Solvents Used.

Cellulose rendered soluble by other means than nitration has also been employed in the manufacture of artificial silk or "lustra-cellulose," as it has been more appropriately termed. Thus in some of the methods of cellulose in an ammoniacal solution of copper oxide is employed, in others the cellulose is dissolved in zinc chloride solution, and in others again, a solution of the compound of carbon bisulphide with alkali-cellulose is used. But the principle underlying them all is the same, that is, the formation of fine filaments of the viscous cellulose solution and subsequent separation of the solvent.

The "Vandenara silk," patented in 1894 by Mr. A. Millon of Glasgow, is the first example of another class of artificial silk, and as regards its chemical composition approximates more closely than the "lustra-cellulose" to the natural product. It is prepared by forcing a concentrated solution of gelatin through small openings on to a rapidly moving endless band, which draws the threads out into fine filaments. These are twisted together and exposed to an atmosphere of formaldehyde vapor, which speedily renders them insoluble in water, and leaves them lustrous and supple. The threads spun from the filaments may be dyed readily any desired color, and are absolutely inflammable, but they have the drawback of being greatly inferior to silk in strength, and this defect becomes more pronounced when they are moistened with water.

Moistening Reduces Strength.

When moistened with water the strength of the silk is little if at all affected, whereas the strength of the lustra-celluloses is reduced to about one-eighth, although on drying they regain their original strength. This drawback of deficient strength is shared by all the artificial silks, though the lustra-celluloses are superior in this respect to gelatine "silk," and all are quite as strong if not stronger than genuine silk that has been "weighted" by the addition of metallic compounds, as is now frequently done. Although quite as lustrous as silk, some of the artificial products have a scintillating appearance which the genuine substance lacks, and all feel harsher to the touch.

With the exception of gelatin "silks," which do not seem to have been extensively employed, artificial silks are readily distinguishable from silk or wool by the fact that they burn without emitting the characteristic smell of burning animal nitrogenous matter.

They may also be distinguished by their appearance under the microscope, especially in transverse section, in which they usually appear as irregular shapes, generally considerably larger than the regular pointed ovals of the transverse sections of ordinary silk.

Various chemical agents may also be employed for their detection and differentiation. Thus a solution of copper oxide in ammonia dissolves both the natural and artificial silks, but on the addition of water the cellulose composing the latter is reprecipitated, whereas no precipitate is obtained from the solution of silk. Again, the Chardannet silk may be differentiated from the viscose silks by the fact that in the case of the former faint traces of nitro-cellulose remain, however carefully the denitiation is carried out. These may be detected by giving a bright blue coloration when the "silk" is treated with a solution of diphen-glamine in strong sulphuric acid.

Their deficiency in strength has prevented artificial silks being used more extensively for clothing, but they are largely employed in the manufacture of ribbons, and for tapestries upholstery and other decorative work in which strength is not a primary consideration, and owing to their relatively low price and beautiful lustre are well suited for such purposes.

Tariff Commission Chemist Sees Bright Future

Grinnell Jones, Chemist to the United States Tariff Commission, Reviews Development of American Chemical Industries Before American Chemical Society and Forecasts Their Possible Future.

WHEN peace is restored the competitive strength of the nations in all industries will have been profoundly altered. Chemistry and machinery have played a larger part in this war than in any previous war, and therefore the greatest changes may be expected in the metal working and in the chemical industries. Moreover, our new American cargo ships will make us more than ever interested in foreign trade. The Tariff Commission is actively studying these war disturbances in order to assist in the readjustment and reconstruction that must follow when peace comes.

Among the chemical industries, the first to feel the stimulus of war was the explosive industry. The expansion of American smokeless powder plants was sufficient to prevent a German victory in France and Russia in 1915. It is not revealing military secrets to say that there has been some growth since 1915. We all hope that the peace terms will be so satisfactory that the military explosive plants themselves will no longer be needed. Nevertheless, there will be a permanent increase in the competitive strength of the American chemical industries through the growth of the subsidiary industries which now supply the raw materials to the explosive industry.

Increase in Acid Making.

Our production of sulphuric acid is at least twice what it was before the war. The growth has been largely in contact acid, and therefore when the demand for explosives disappears, the American chemical industries will have available large supplies of pure and concentrated sulphuric acid. Moreover, the growth of the acid industry has been made possible by a great increase in the production of American sulphur and by a smaller although signification increase in the mining of pyrites.

The nitric acid industry has grown relatively more than the sulphuric acid industry. The output of nitric acid from Chilean niter is now more than ten times as great as it was before the war.

The significance of this growth of the sulphuric and the nitric acid industries to our dynamite, dyestuff and pyroxylin plastic industries need not be emphasized here.

Of greater significance than this stimulus to industries already well established has been the birth of new industries. We have a new synthetic ammonia and nitric acid industry. Plants have been built and, during the war at least, will be operated by the Government. When the full story of these plants can be told, it will reveal that American chemists have, under the pressure of war needs, been able to devise substantial improvements upon the Haber and Ostwald processes developed by the Germans before the war. These processes were the result of nearly two decades of work on these problems as a part of their military preparedness. It is not improbable that after the war nitric acid made from synthetic ammonia may prove to be cheaper than nitric acid made from Chilean niter. In any case American agriculture will assuredly have a new large source of nitrogenous fertilizer materials.

Oil Production Grows

In 1914 our production of crude light oil would have been sufficient for the production of only about 4,500,000 gallons of benzol and of about 1,500,000 gallons of toluol, and only a part of which was distilled. As is shown in our forthcoming report on the production of American dyes and coal tar chemicals, in 1917 our putput of benzol was 40,200,000 gallons, and of toluol, was 10,200,000 gallons. In 1918 further substantial growth is to be expected through the installation of stripping plants at city gas works. The toluol is now going almost entirely into explosives as is also a considerable fraction of the benzol. When the demand for explosives disappears, it is to be expected that the prices of benzol and toluol will drop to the point where it will be profitable to add them to gasoline for motor fuel. A similar condition will probably exist abroad, and, since America has the greatest known natural resources for the production of gasoline, benzol and toluol should be as cheap or cheaper here than abroad. Therefore the industries consuming benzol and toluol may be assured of ample supplies of these materials at favorable prices.

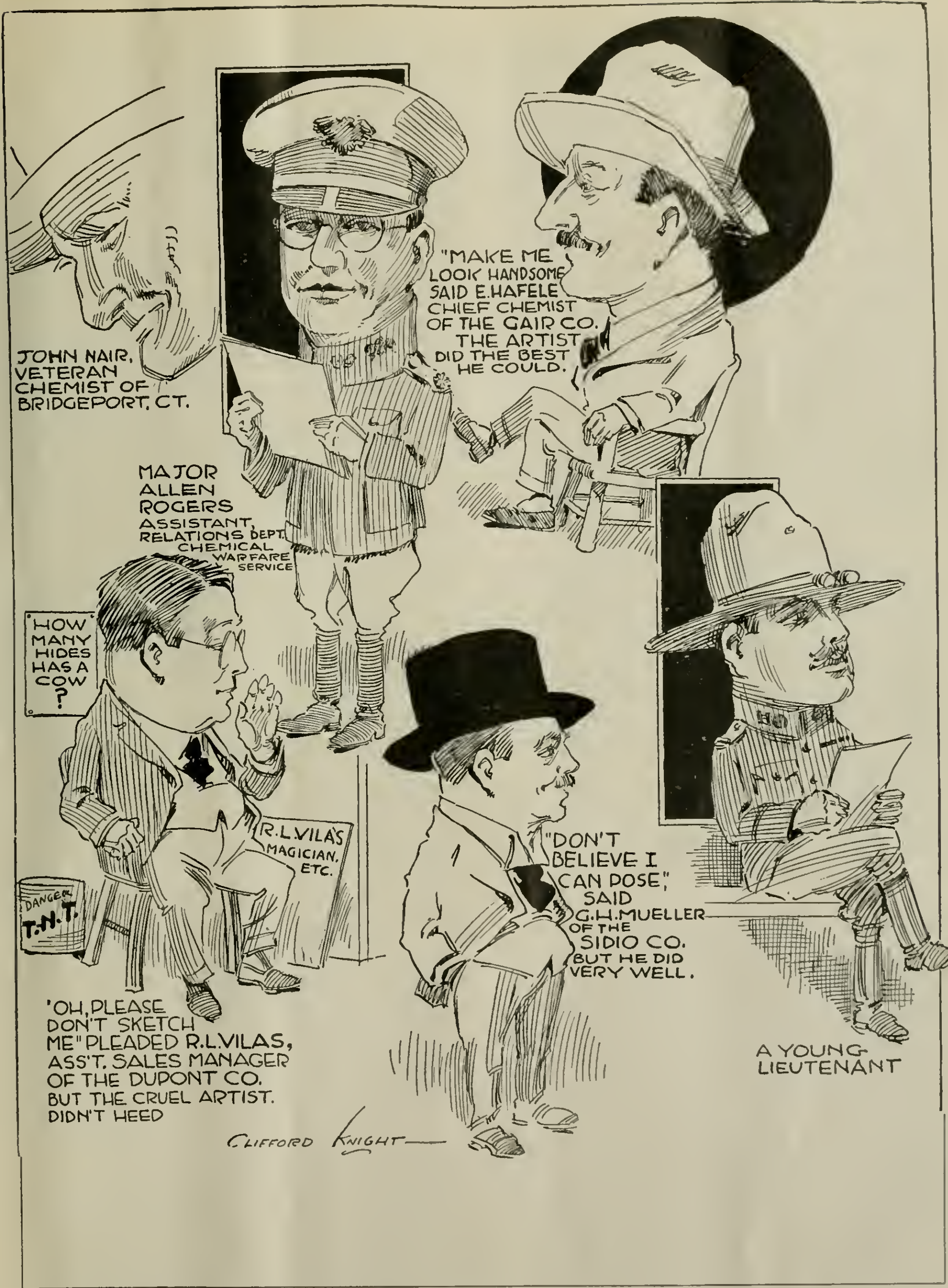
The Future for Phenol.

Before the war we had no synthetic phenol industry, whereas in 1917, as is shown in our forthcoming report, 15 plants produced 64,146,499 pounds of phenol valued at $23,715,805, most of which was used in making picric acid. If this new industry is to survive, there must be a greater consumption of

A. F. WIEHL OF THE H. A. METZ & CO. INC. GOES IN FOR "COLOR"
COL. MARSTON T. BOGERT
MAJ. F. E. BREITHUT.
MAJ. F. M. DORSEY
A TRIO OF PROMINENT CHEMICAL WARFARE OFFICERS
METZ ANILINE COLORS & CHEMICALS
H. A. METZ
DR. LOUIS J. MATOS OF THE NAT'L ANILINE & CHEMICAL CO. (ABOVE)
FOURTH NAT'L EXPO. CHEMICAL INDUSTRIES
GRAND CENTRAL PALACE
HERE'S CORP. C. F. ROTH WHO STAGED THE "BIG SHOW" AT THE GRAND CENTRAL PALACE
MAURICE A. KNIGHT'S CHEMICAL STONEWARE FROM AKRON OHIO
Pvt. LEO H. LUDWIG WHO WAS GASSED IN FRANCE: FORMERLY WITH THE GRASSELLI COMPANY.
SKETCHED BY CLIFFORD KNIGHT AT THE EXPO.

SOME OF THE CHEMISTS, MILITARY AND CIVIL, WHO ARE HELPING UNCLE SAM WIN THE WAR.

Thanks chiefly to the presence of many members of the Chemical Warfare Service there was a distinct war atmosphere apparent at the Fourth Chemical Exposition.


JOHN NAIR, VETERAN CHEMIST OF BRIDGEPORT, CT.
"MAKE ME LOOK HANDSOME" SAID E. HAFELE CHIEF CHEMIST OF THE GAIR CO. THE ARTIST DID THE BEST HE COULD.
MAJOR ALLEN ROGERS ASSISTANT, RELATIONS DEPT. CHEMICAL WARFARE SERVICE
"HOW MANY HIDES HAS A COW ?"
R.L.VILA'S MAGICIAN, ETC.
DANGER T.N.T.
"DON'T BELIEVE I CAN POSE", SAID G.H.MUELLER OF THE SIDIO CO. BUT HE DID VERY WELL.
'OH, PLEASE DON'T SKETCH ME" PLEADED R.L.VILAS, ASS'T. SALES MANAGER OF THE DUPONT CO. BUT THE CRUEL ARTIST. DIDN'T HEED
A YOUNG LIEUTENANT
CLIFFORD KNIGHT

A FEW MORE OF THE VISITORS TO THE SHOW IN CHARACTERISTIC ATTITUDES.

Chemists are proverbially modest, but by dint of a little diplomacy The Chemical Engineer artist persuaded a number of them to have their "picture took."

(*Continued from page* 419.)

phenol in the industries for peaceful purposes. Fortunately, phenol is used as an intermediate in the manufacture of some representatives of every class of finished coal-tar chemical products, including dyes and lakes, photographic developers, medicinals, flavors, perfume materials, synthetic rosins, synthetic tanning materials and explosives. Leaders in the chemical industries are already making plans for the industrial development of the uses of phenol when the phenol is no longer needed for explosives.

Another war-baby is monochlerbenzol, which was made during 1917 by eight American firms, with an output of nearly twenty-five million pounds, valued at a little less than five million dollars. The dye industry will use a part of this productive capacity permanently, but new discoveries by American chemists will probably be needed to utilize the total productive capacity. Incidentally, this product furnishes a new outlet for chlorine, a new by-product source of muriatic acid, and raises a new problem in the utilization of dichlor-benzol, an unavoidable by-product.

An Industry Built to Last.

Before the war there was but one producer of anilin oil in the United States. In 1917 there were twenty-three producers with an output of 28,806,524 pounds, valued at $6,758,535. As only a relatively small proportion of this substance goes into explosives, the peace readjustments will not be complicated by a collapse of a military demand, but will depend primarily on the competitive strength of the American industry.

The war has also stimulated the production of mercury for the manufacture of fulminates. The American production has about doubled since the beginning of the war. Formerly we had a balance of imports—now we have a larger balance of exports.

Poison gas warfare is also destined to have a permanent influence in the chemical industries. Although there is no reason to expect that uses will be found for phosgene and mustard gas on a scale approaching the present and prospective military use, the plants erected for their manufacture need not prove a total loss when the military demand ceases. Nearly all of the noxious substances used in poison gas warfare require chlorine for their manufacture, and an increase in the production of chlorine in the United States is therefore certain. There is much hope that some of the substances produced as intermediate steps in the manufacture of the poison gases may be utilized for purposes other than warfare, but these are matters not yet to be discussed. Phosgene, except for the dangers attending its use, is an excellent reagent for many processes involving chlorination or dehydration and for making Eichler's ketone. Fortunately, the risk in using phosgene is greatly minimized by the development of the new gas mask. The intensive work which hundreds of American chemists have been and are doing to improve the design of the gas mask will undoubtedly prove a blessing to workmen exposed to noxious fumes in chemical factories throughout the world when peace is restored.

War's Effect on Acetone.

Still another industry which has been stimulated by a direct war demand, is the manufacture of acetone, which is used as a gelatinizing agent in the manufacture of the explosive, cordite; as a solvent for airplane dopes; and in the manufacture of poison gases. Before the war acetone was obtained entirely as one of the products of the wood distillation industry, but there are now at least four new processes in commercial operation in the United States or Canada for the manufacture of acetone.

It has been found that glucose can be fermented by a suitable organism to give acetone directly. Butyl alcohol, is a by-product of this fermentation, and becomes commercially available in appreciable amounts. The development of uses for butyl alcohol is an attractive problem.

The other processes for making acetone produce acetic acid or an acetate as an intermediate step, and may therefore permanently affect the acetic acid industry. The most obvious and perhaps the simplest of these processes depends on fermenting molasses to alcohol, which is then converted into acetic acid by the rapid vinegar process. The conversion of acetic acid into acetone is an old and well-known process, but the details have been improved.

Another process depends on making acetylene from calcium carbide. By the aid of a suitable catalyst, the acetylene is made to combine with water yielding acetaldehyde which may be readily oxidized to acetic acid. Still another process depends on fermenting kelp under such conditions that sodium acetate and potassium salts are secured.

Dyestuff Industry's Future.

The war has stimulated the production of many other products, a few of which may be briefly mentioned; castor oil for lubricating airplane motors; phosphorus for incendiary bombs; barium and strontium nitrates for signal rockets. The output of soda ash has increased by 68 per cent. since 1914, and the output of caustic soda has more than doubled.

New conditions in the chemical industries have also been created by the curtailment of imports. As a direct consequence of this stoppage of imports from Germany a new American dye industry has been established. It is true that some dyes were being made in the United States before the war, but the makers relied on Germany for the necessary intermediates, with the exception of a small amount of anilin made here by a single producer. During

(*Continued to page* 431.)

Time for Changed Educational Policy

Prof. William Jackson Pope, C.B.E., D.Sc., F.R.S., Tells Members of British Chemical Society That Hereafter Education Must Be More Scientific and Practical—War Has Discredited So-Called "Classical" Education.

COMING from the president of the most important body of chemists of Great Britain, and containing, as it therefore does, the gist of the lessons learned by that country as the result of over four years of war, the following speech, delivered by Prof. William Jackson Pope, president of the Society of Chemists of Great Britain, should prove particularly illuminating to those interested in the promotion of scientific education in the United States. It contains a number of lessons which American educators would do well to study and put into practice:—

For three years past pure chemical research has been dormant the whole world over, and it would be difficult fo rthe most accomplished essayist to arrest your attention for an hour by an address on a subject of purely academic interest. Our mental point of view and our outlook upon both present and future are entirely different from those of four years ago; although the present is obscure and painful, the future gives promise of brilliant and rapid developments in natural science in general and in chemistry in particular. In this belief I venture to lay before you some reflections upon the growing recognition of importance of our science and upon the responsibilities with which, owing to this change in public opinion, our shoulders are laden.

Anyone who is in the habit of reading modern historical writers—and they have become quite illuminating since a scientific mode of writing history has been substituted for the older fictional style—knows how political changes, national reforms arising from an effort of the collective conscience, the magnetic influence of some popular demagogue, and the like, are invariably invoked as explanatory of all the vicissitudes of our planet.

The modern historian is here taking a false point of view, and, since he is, in general, quite unacquainted with physical science, his methods are inadequate. The whole history of Europe for the last century has been made within a few hundred yards of Burlington House in our scientific laboratories. One of the most potent incentives to political changes resides in the desire to increase the amenities of life, and research in pure science has had for a hundred years past the greatest influence in facilitating the realization of that desire. trations of the stultifying effect of a purely classical education are laid before us every day; one recent example may be quoted here. The gentleman who shares with Mr. A. J. Balfour the honor of representing in Parliament the greatest centre of business and financial activity in the world made the following statement in the House of Commons recently whilst opposing Mr. Fisher's Education Bill: "It was said that education was necessary to make the rising generation good business men. His experience in the city was that the man who took Firsts at Oxford generally came out last, and that ehe man who could hardly write his name generally came out first. The explanation was that education could not put into a man that instinct of self-preservation and common sense which was the foundation of all sucess in business. How could education assist a farm laborer to spread manure on a field. The best laborer he had known was wholly illiterate. If the waste of the war was to be replaced it would be necessary for the young men to start as early as possible in doing a day's work, instead of wasting time on useless book learning." This representative of the city of London is a baront of recent creation and a director of one of the largest London banks and of one of the most important railroads; he received his "education" at one of the oldest and most rigidly classical of our great public schools. Comment is probably unnecesary.

Science and Literature

Every scientific man in the world realizes that an innate appreciation for fine literature, for great thoughst nobly expressed, and for the appropriate delineation of our greatest aspirations, are among the most sublime instincts of humanity and demand the most careful cultivation. Our literary men say that we cannot express ourselves effectively, and offer as a satisfying feast the old bones left us by the Greeks and Latins, chewed over for centuries until so devoid of nutriment that they led ultimately to the mental atrophy which characterized the Middle Ages, an atrophy that was only shaken off by the taste for calknowledge which arose from the exploits of geographical science in the Elizabethan period.

If the power of expression rests with our literary friends, why are they so idle? It is their obvious duty to devote themselves to popularizing the natural knowledge acquired by the scientific observers of the past two centuries; this real learning has so infinitely extended human interest in the world around us and gives such promise of further conquests that an appeal for its consideration would certainly not have been made in vain to Plato or Lucretius. No one asks for the abolition of classical literary learning, but the whole world is now demanding that the young should be provided with an education which includes an insight into our present-day knowledge of the universe.

The rather petty disputes which rage about this matter of classical and scientific education are one-sided; the scientific man generally knows something of both aspects of the subject, whilst his classical compeer rarely has any acquaintance with science. Unfortunately, the great questions involved have more than a petty bearing upon the well-being of our nation. The classical school has held the country in such bondage that, to all practical intent, no person can be admitted to the higher public service unless he swear adhesion to the caste. It is almost regarded as a platitude that acquaintance with natural science disables a man from fulfilling any high public office; practically all the superior positions in the Civil and Diplomatic Services must be filed by men of classical instincts.

Experience Has Discredited Method.

I venture to think that the wisdom of this mode of selection has been seriously impugned during the last four years. The huge Government departments which classes—those staffed by men of some scientific training and those staffed by classical university graduates. have arisen of late many be divided roughly into two Anyone who has had occasion to note the numerous recent criticisms on Government departments must have observed that these strictures have almost invariably ben passed on administrative branches of the service; delay, the encumbrance of red-tape, and inability to draw a decision, seem indigenious in certain Government offices, and none of the numerous attempts at reform has been successful. The adiministrative services are those in which thec lassical man is predominant. Other branches, such as the home Army Medical Service, have practically never been charged with inefficiency; the worst that has been alleged is a suggestion of extravagance.

The department just named is staffed by men who have had, at least, the rudiments of a scientific education; if control in the Royal Army Medical Service had been vested in the classical scholar of ability but no knowledge, it is certain that the last three years would have seen a repetition of the horrors of the Crimean campaign, and that the army mortality from disease would have been greater than that caused by the ordinary instruments of war.

Such a control, happily, has been avoided; it has been avoided merely because medicine possesses the collective organization for which I plead in chemistry, an organization so strong as to make the imposition of an irresponsible lay control unthinkable.

I have already directed attention to the frequently expressed opinion that, as a nation, we are incapable of excelling in the fine organic chemical industry; let me quote one instance, small in itself, but large in its consequences, in disproof of this view.

The ordinary photographic plate is sensitive only to a region in the blue of the spectrum, but by incorporating certain rather fugitive organic dyes with the sensitive film, the later may be rendered sensitive to the green, yellow, and red parts of the spectrum; photographic plates so treated are described as panchromatic. The quantities of the sensitizing dyes required for the whole world's consumption in normal times is minute, being, indeed, of the order of a few pounds per annum. Until 1915 these substances had never been made outside Central Europe, and little was known by us of their compositions or of the methods of preparing them, as they were all sold under trade names. The manufacture of these materials, small as was the business, had been industriously cultivated by the German color works, and, as these color sensitizers are essential in aerial photography, their scarcity became of serious import quite early in the war.

What Chemists Have Done.

The experimental investigation of the whole subject was quickly put in hand in this country, and within a few months ample supplies of the usual sensitizers were produced. Further, the newly established Department of Scientific and Industrial Research financed the development of the study of photographic sensitizers; as a result of this action new sensitizing dyes have been produced which are far superior to the older ones. It is safe to assert that the manufacture of panchromatic plates has now attained a degree of perfection in this country such as will long defy competition.

This is but one case that may be quoted from among a host of others, all of which prove conclusively that, given a little encouragement and assistance, British chemistry is capable, not only of giving much needed relief in this time of strain, but of meeting every demand which can be made on it when thep eriod of reconstruction comences.

Whilst the absence of the powerful weapon provided by a collective chemical Council, embracing all interests of the science, has made it impossible for us to render the most economical service to our country, it is perhaps satisfactory to reflect that hitherto all that has been sacrificed is economy. Our lact of power to enforce our views has led to financial extravagance on the part of the authorities; the lack of economy in time, which means lives, cannot be attributed to our chemists. The duty will fall to some future President at some later time to record the spontaneity with which the Fellows of this Society volunteered for service in our chemical works, our munition factories, and with the Colors either in our gas service or elsewhere.

(Continued on page 431)

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By CARLETON ELLIS and A. A. WELLS*

Part XVIII

Resonance Spectra.

According to *Wood* (Phil. Mag., 1908, (vi), 15, 581) sodium vapor heated to about 400°, in an exhausted steel tube, shows an extremely complex absorption spectrum consisting of a multitude of very fine absorption lines; the very large scale photographs taken show, for example, about 6,000 lines in the bluish green. If the vapor is illuminated with white light, it becomes fluorescent and gives an emission spectrum which is the exact counterpart of the absorption spectrum. By exciting the vapor monochromatic light, only a few lines appear in the emission spectrum. These spectra are called "resonance spectra," because they appear to be due to resonance of an electron of the system when nonchromatic radiation plays upon it. Only light of certain wave-lengths can excite the resonance spectra, for example, the line 5,209 is the ony one in the spectrum of the silver arc which is active. The electron theory indicates that a non-radiating system of electrons, when disturbed by absorption of radiation of the same frequency as that of one of the electrons, should emit radiations giving a system of equally spaced lines.

Mercury, Cadmium and Zinc.

McLennan and *Edwards* (Phil. Mag., 1915, (iv), *30*, 695) note that the ultra violet absorption spectra of the non-luminous vapors of mercury, cadimum, and zinc, show strong symmetrically spaced bands and narrow, sharply defined bands. In addition, the mercury spectrum shows a diffuse, complex band, for which there are no analogues in the cadmium and zinc spectra.

Absorption by Halogen Salts.

Retchinsky (Ann. Physik, 1913, (iv), 42, 1680; J. Chem. Coc., 1914, *Abs.*, 106, ii, 83) has examined the ultra violet absorption of lithium chloride, lithium bromide, sodium chloride, sodium bromide, sodium iodide, and potassium iodide in aqueous solutions of varying concentration. All these salts show a strong absorption maximum in the extreme ultra violet beyond λ = 220 μμ. The absorption curve is shifted towards greater wave-lengths when the temperature is raised to 100° in the case of sodium chloride, lithium bromide, sodium bromide and potassium iodide, but no shift is observed with lithium chloride. When the limiting absorption of the dissolved salts is compared with that found for the molten salts it is found that the straight lines which represent the influence of temperature in the case of the molten salts pass through the points which correspond with the limiting absorption in aqueous solution at 20° and 100.° *Houston* (Proc. Roy. Soc. Edin. 1912, *32*, 40; J. Chem. Soc. 1912, Abs., *102*, ii, 507) examined the absorption spectra of various salts of copper, silver, lithium, sodium, potassium, rubidium, and caesium and found the absorption in the ultra violet to be very small except in the case of the nitrates. *Massol* and *Faucon* (Compt. rend., 1914, 159, 174; J. Chem. Soc. 1914, Abs., *106*, ii, 694) find that copper nitrate falls into line with other metallic nitrates in giving the ultra violet absorption band of nitric acid, providing that a sufficient thickness of solution is used. The band is, however, less sharply defined, an aqueous solution of copper nitrate being more transparent to the rays between λ 3150 and 2800 than solutions of the other nitrates.

Drossbach (Ber. 1902, 35, 91) in determining how far certain substances (mostly in 10 per cent. solution) absorb the ultra violet rays found a marked absorption in the case of some salts of heavy metals, nitrates, and organic substances with high molecular weight. Hydrochloric acid, sulphuric acid, potassium chloride, chlorate and sulphate, sodium and calcium chlorides, aluminum and manganese, sulphates were found to be transparent, that is, light up to 230 μμ passed through these as easily as through water.

·*Retschinsky* (Ann. Physik. 1908, (iv), 27, 100) has made an examination of the absorption spectra of some thirty molten inorganic salts, the result of which shows that, in all cases, there is a well-defined limit to the absorption band on the ultra violet side of spectrum, all radiation of smaller wave-length than that corresponding with the limiting value being completely absorbed. With rise of temperature this limit is displaced in the direction of greater wave-lengths.

Mercury Salts.

In a study of the light absorption of some metallic salts on the nature of the linking, *Ley* and *Fisher* (Zeitsch. anorg. Chem. 1913, 82, 329) state that the ultra violet absorption of mercuric salts is displaced towards longer wave-lengths in passing from the chloride to the iodide, the bromide being exactly intermediate. Mercuric cyanide is almost as diactinic as water, and much more so than mercuric ions, a result which is explained by the presence of a mercury-carbon linking. In acordance with this, mercuric methyl chloride and mercuric ethyl chloride absorb less than mercuric chloride. On the other hand, compounds with mercury linked to nitrogen, such as mercury propionamide and mercury succinimide, have a high absorption. Mercuric perchlorate absorbs more than the mercuric salt favoring the view that a bivalent complexion $(Hg\,.\,Hg)^{\cdot\cdot}$ is present.

---

*All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

Other Inorganic Compounds.

The behavior of alcoholic solutions of copper, cobalt, and nickel salts in ultra violet light has been investigated by *Brown* (Pros. Roy. Soc., Edin., 1913, *33*, 44). The salts examined were the chlorides and bromides, and in the case of copper, the sulphate, observations being made over the region $\lambda = 265\ \mu\mu$ to $\lambda = 450\ \mu\mu$. The calculated molecular extinction coefficients are plotted against the wave-lengths, and the resulting curves are compared. *Jones* and *Anderson* (Amer. Chem. J. 1909, 41, 163 and 276) have obtained photographic records of the absorption spectra of solutions of cobalt chloride, bromide, nitrate, sulphate, thiocyanate, and acetate, and of nickel, cupric, ferric, and chromic chlorides. The ultra violet absorption exhibited by aqueous solutions of cobalt salts diminishes with dilution and increases with rise in temperature. *Anderson* (Proc. Roy. Soc. Edin., 1913, 33, 35; J. Chem. Soc. 1913, Abs. 104, ii, 454) has investigated the light absorption of aqueous solutions of ferric chloride, bromide, nitrate, and sulphate, and ferrous chloride and sulphate. *Massol* and *Faucon* (Compt. rend., 1913, *157*, 332) have made a study of the absorption of the ultra violet rays by aqueous solutions of such substances as potassium ferrocyanide, gold chloride, copper sulphate, etc. These bodies exhibit various powers of absorbing ultra violet rays, and are far less powerful than synthetic organic dyes although qualitatively the absorption is of the same order, and in the case of band spectra, broad absorption bands occur in the same regions of the spectrum, these depending on the color, and not on the chemical constitution of the substance. An attempt was made by *Jaeschke and Meyer* (Zeitsch. Physikal. Chem. 1913, *83* 281) to find a relationship between the color of derivatives of manganese compounds and the valency it is exhibiting in these compounds. For this purpose the absorption spectra of potassium permanganate, potassium manganate, the doubtful manganese tetrachloride, manganic chloride, manganic sulphate, manganic phosphate, manganous chloride, and manganous sulphate were determined. *Jaeschke and Meyer* state that the violet end of the spectrum is most sensitive to changes in valency, but that they are unable to make any measurements in that region or in the ultra violet portion of the spectrum. *Walter* (Physikal. Zeitsch., 1912, *13*, 6) has obtained photographs of the absorption spectra of the phosphorescent alkaline earth metal sulphides containing bismuth as "active impurity." The spectra are characterized by strong absorption bands.

Organic Nickel Compounds.

The nickel derivatives of methyl and ethyl-nitroamines have been prepared and their absorption spectra compared with that of nickel nitrate by *Franchimont* and *Backer* (Rec. Trav. chim., 1913, 32, 321; J. Chem. Soc. 1914, Abs., *106*, ii, 83). The absorption curves for the methyl and ethyl-nitroamine derivatives coincide over practically their whole length, and the absorption is complete in the ultra violet. The absorption spectra of some dioximes have been examined by *Tschugaev* and *Glebko* (Zeitsch. Anorg. Chem., 1914, *89*, 241) by means of a quartz spectrograph. The dioximes of nickel exhibit absorption in the visible and ultra violet region, the characteristic band having its maximum between $1/\lambda$ 3,500 and 4,000. The ∝ dioximes themselves have only continuous absorption. Cobalt palladium and platinum dioximes also exhibit absorption in the ultra violet region.

In determining the absorption spectrum of twenty complex cobaltammine salts, *Luther* and *Nikolopulos* (Zeitsch. Physikal. Chem., 1913, 82, 361) measured the visible portion of the spectrum by a spectrophotometer using a mercury vapor lamp as the source of light, and the ultra violet portion was measured by Hartley's method using a quartz spectrograph and an iron spark as source of light. The various errors of the method are discussed, and an approximate estimate of their dimensions is made. It is shown that the light absorption is dependent on the composition of the complex. The replacement of NH_3 by NO_3, H_2O, Cl and Br in the complex causes a displacement of the absorption towards the red end of the spectrum. Replacement of NH_3 by NO_3 causes a displacement toward the violet end.

Shibata and *Urbain* (Compt. rend., 1913, 157, 593) have made a study of the absorption spectra of solutions of twenty-four complex cobalt salts in the visible and ultra violet portions of the spectrum, the results pointing towards certain relations between the constitutions of the complex salts and their absorption. Curves obtained by plotting the thickness of the solutions against the frequency limits of absorption show two decided minima in the neighborhoods of λ 2,000 and λ 3,000. These two bands seem to be characteristic of the tervalent cobalt atom functioning as chromophore.

Guy and *Jones* (Amer. Chem. J., 1913, 50, 257) have studied the absorption spectra of salts of neodymium, praseodymium, nickel and cobalt, and compounds of the latter element were found to have a strong ultra violet absorption.

Hantzsch (Ber. 1908, *41*, 1216) investigated the intensities of solutions of hydrogen platinichloride and sodium platinichloride of widely varying concentrations and in various solvents. These substances were chosen as objects for investigation because they contain the completely saturated complex $PtCl_6$, and are consequently not affected by the solvent. It is found that equivalent solutions of the acid and of the salt in the same solvent are optically identical, that is, show the same absorption spectrum, and that the molecular absorption is independent of the degree of ionisation.

(*Continued on page* 432.)

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors. Synthetic Medicinals, Flavors and Perfumes. Explosives, Photographic Developers.

A New Aniline Black with a Titanium Base

By Ellon R. Darling

FROM time to time there has appeared a number of methods for the production of aniline blacks. Some recommend the use of one bath and others two baths. Both methods have their advantages. In most of the two bath methods sodium chlorate and hydrochloric acid are used in the first bath and sulfuric acid in the second. But it must be remembered in considering the respective merits of the various methods that the action of mineral acids upon cotton is not of the best and it is necessary in most cases when mineral acids are used in the treatment of cotton goods to take the utmost precaution to prevent the injury to the tensile strength of the materials being treated. Even under the best of conditions a slight tendering is likely to result. Losses of as much as 21% in tensile strength have been discovered by the writer in the course of a number of experiments he has made with aniline blacks made with methods employing mineral acids.

The writer has found that by making use of a low priced organic acid much of the trouble now experienced with aniline blacks can be eliminated.

A suggested method is as follows: A titanium aniline chloride is first prepared. This organometallic salt is insoluable in water but is readily soluble in weak acids. This scale is used as a base for the fixing of the color.

The method the writer used for the dyeing of the color in one bath involved first of all the treatment of the yarn for twelve hours in a five per cent. solution of tannic acid. It was then dried. While the yarn was being treated a bath made up of the following ingredients was prepared:

2%	titanium aniline chloride
3%	aniline oil
15%	44% lactic acid
8%	bichromate of soda
6%	copper lactate

The titanium aniline chloride and aniline oil were first added to the lactic acid and solution effected. Water was then added to volume and the bichromate of soda added (in solution). The whole was well stirred and the copper lactate added after being dissolved in water. The whole was well agitated. The goods to be dyed were then placed in the bath and allowed to remain there for an hour. At the end of that period the temperature of the bath was slowly raised to boiling point and kept there for thirty minutes. The goods were then removed, rinsed and dried.

By this method the writer has found that a jet black color is obtained which possesses all the properties which are obtained when the methods employing sulfuric and hydrochloric acids are used.

The titanium aniline chloride forms an insoluble titanium tannate on the goods which in the present of the oxidizing agent becomes insoluble metatitanic acid. This acid has a strong affinity for the color base and a deeper shade of color is obtained.

A number of trial tests run with the above method and one where mineral acid were employed showed that 25 per cent. more goods could be treated with the same depth of color as when the other method was employed.

Little or no difficulty was experienced when running the method on a commercial scale. Tests run on the tensile strength and the presence of oxycellulose in the fibre showed a marked advantage over the other method.

Tariff Commission Issues Dye and Coal Tar Census

The remarkable success of the American chemists and chemical manufacturers in developing the dyestuffs industry, when the supplies of dyes from Germany were cut off, is strikingly shown in a report just issued by the United States Tariff Commission, entitled "Census of Dyes and Coal-Tar Chemicals, 1917."

At the outbreak of the European war, Germany dominated the world's trade in dyes and drugs derived from coal-tar. Before the war, seven American firms manufactured dyes from imported German materials. In 1917, 190 American concerns were engaged in the manufacture of dyes, drugs, and other chemicals derived from coal-tar, and of this number, 81 firms produced coal-tar dyes from American materials which were approximately equivalent in total weight to the annual imports before the war. The total output of the 190 firms, exclusive of those engaged in the manufacture of explosives and synthetic resins, was over 54,000,000 pounds with a value of about 69 million dollars.

Large amounts of the staple dyes for which there is a great demand are now being manufactured in the United States. A few of the important dyes, such as the vat dyes derived from alizarin, anthracene, and carbazol, are still not made. The needs of the wool industry are being more satisfactorily met than the needs of the cotton industry.

The report gives in detail the names of the manufacturers of each dye or other product and the quantity and value of each produced, except in cases where the number of producers is so small that the operations of individual firms would be disclosed. Seventeen hundred and thirty-three chemists or engineers were engaged in research and chemical control of this new industry, or 8.8 per cent. of the total of 19,643 employees. The report also contains an interesting account of the history and development of the industry since the outbreak of the European war.

Progress in the British and French Dyestuff Industries

In the second annual report of the powerful organization, "British Dyes, Ltd.," there is much of encouragement in the outlook, but emphasis is laid upon the many obstacles in the way of erecting a complete national color industry.

The British company has now a capital of $10,155,000, of which $5,568,000 has been loaned by the Government, and is able to declare a dividend of 6 per cent., the maximum allowed under its charter.

There seems to have been a steady expansion throughout the year. Among the notable advances is the construction of a large factory for the manufacture of azo colors, now in full operation. The manufacture of vat colors has been taken up energetically. Two dyes, a blue and a yellow, of the Indanthrene type, are now regularly supplied and others in this group will soon be added to the list. Several direct cotton colors, a yellow, a violet and a green, have been introduced in this category of dyes, and the range of shades for direct wool colors has been materially enlarged. The output of Methylene Blue has been greatly increased. As is to be expected, the demand for khaki tints—brown, green and yellow—has been enormous, but it has been possible to meet all needs of the English Government, as well as most requirements of allied governments in this connection. The same may be said for all other dyes employed on leather and textiles needed for military purposes. Prominent among these is an alizarin blue of exceptional fastness.

Large installations for the production of b-naphthol and of p-nitraniline have been completed during the year. Several other plants for the manufacture on an ample scale of additional intermediates are nearing completion, and will contribute materially to a much broader range of colors.

Among other features of construction may be mentioned a power gas plant, a 2,000,000-gallon water reservoir, a piping system for the distribution of steam, gas and compressed air throughout the works, an independent electrical installation, a railway system with branches to all buildings. These items illustrate the variety of mechanical factors entering into the evolution of large, self-contained color works.

The chemical staff of the company now numbers 100, and steps have been taken to provide for the adequate training of a number of young men so as to ensure sufficient material for constant increase in the corps of chemists. This provision is in harmony with the plans for erecting a large research laboratory at Huddersfield. Temporarily, advanced investigation, under the direction of the company, is carried on in the laboratories of the Universities of Oxford, Leeds and Liverpool.

This full recognition of the imperative need of high-grade research work if the national industry is to become independent and able to face a multitude of problems in the early future, shows that the management of the company is determined not to repeat the mistake which led to the relative stagnation in British dyestuff industries for so many years.

Two Big Government Acid Plants to Be Erected

Two sulphuric acid plants are to be erected in Pennsylvania under the supervision of the Construction Division of the Army. The estimated cost for both plants is $3,000,000.

One plant will be located at Emporium, while the other will be erected at Mt. Union.

The Emporium plant will consist of eight units on a site which has been selected upon Driftwood Creek, close to the plants of the Aetna Explosive Company and the Emporium Iron Company. In the event that sufficient power cannot be obtained from the plant of the iron company, a one-thousand kilowatt power plant will be erected. The estimated cost of this plant is $2,000,000.

The Mt. Union plant will be erected adjacent to the plant of the Aetna Explosives Company. Twenty acres of land have been purchased at $56 an acre. The contract has been awarded to the Leonard Construction Company. The preparation of all plans and specifications, in addition to the supervision of the work, will be under the direction of the construction division.

These plants will be operated by the Government.

The Mid West Ore Company of Eddyville, N. Y., has been incorporated with an authorized capital of $90,000. The company is authorized by its charter to conduct mining or the manufacture of metals, nitrates and chemicals. The incorporators are A. P. Anderson, B. B. Bachwitz and F. Freeman, all of 34 Nassau Street, New York City.

Chemist Sees Bright Future

(*Concluded from page 422.*)

1917, 134 different intermediates were made by 118 firms. One firm made 63 different intermediates. Dyes were made by 81 firms. The total production of dyes in the United States during 1917 was approximately equal in gross weight to the annual importation before the war. The exports of American dyes exceeded in value, although not in quantity or variety, our imports before the war. The dye industry is not dependent on any imported raw material except sodium nitrate from Chili. Many important dyes are still lacking, but indigo and alizarin are now on the market in significant amounts, and the vat dyes for cotton derived from anthracene are coming.

A new potash industry has also arisen, but its future does not seem so promising as the future of the new dye industry. Here Germany has in inherent geological and geographical advantage. Although shipments from Germany ceased early in 1915, and although prices have advanced to about ten times the pre-war prices, the American production during 1917 was only about thirteen per cent. of our pre-war consumption. This relatively small production was obtained from any sources and by many processes. There is an excellent prospect that the recovery of potash as a by-product of cement mills will survive German competition and ultimately supply about one-third of our needs. In addition significant amounts will probably be secured as a by-product of the pig iron blast furnace. That the other branches of the potash industry can survive German competition is open to serious question.

What Embargoes Did to Trade.

Within a few months after the outbreak of the war, imports to the United States from Germany and her allies came to an end. As the months went by, it became increasingly difficult to obtain cargo space for imports from any part of the world. Now the limiting factor in the American participation in the war is shipping for our troops and their supplies, and therefore ships are no longer free to seek the most profitable cargo and route, but are being assigned to routes and cargoes by the Shipping Board on the basis of military needs rather than profits. The Shipping Board has organized a Division of Planning and Statistics, which is making a study of world commerce and the military and civil requirements, for the purpose of utilizing available shipping in a way that will contribute most to the winning of the war. Military requirements make it essential that an abnormally large proportion of the world's shipping shall be used in the North Atlantic. This has made it necessary to curtail imports from other parts of the world to essential requirements.

W. B. D. Penniman of Baltimore is the chemist on the staff of the Shipping Board. He must decide what chemicals need not be imported at all, and the amounts of others which must be imported to supply essential needs. The importance of this work can perhaps best be made clear by an example. The Shipping Board, after consultation with the Food Administration, decided that ships could not be spared for the importation of tapioca from Java and the Straits Settlements. The War Trade Board accordingly announced that licenses for the importation of tapioca would not be granted. Efforts were immediately made to secure a modification of this order on behalf of manufacturers of nitro-starch for the army, and on behalf of manufacturers of mucilage for the Post Office Department. Nitro-starch which, in the United States at least, was hardly beyond the experimental stage at the outbreak of the war, has been improved until it is one of the safest of all explosives to handle and finds important military uses. Until a few months ago it was made from tapioca. Penniman, however, succeeded in convincing the officers of the War Department and the manufacturers that a satisfactory product could be made from corn-starch. The details of the manufacture have been worked out co-operatively by the starch producers, the manufacturers of nitro-starch, and the experts of the War Department with such success that nitro-starch from corn is not only better but more economically produced than nitro-starch from tapioca. The Post Office Department also readily agreed to use some locally available material instead of tapioca for mucilage on stamps. The shipping saved on this one item of tapioca for nitro-starch is sufficient to transport and sustain in France more than twenty-five thousand fighting men. Mr. Penniman's services to the nation on questions of this character deserves to be better known and appreciated. Imported materials for the time being should be used with the utmost economy and only for essential needs. American chemists can render valuable public service by finding substitutes for materials which must be imported from overseas.

Permanent Value of Discoveries.

It seems probable that many of the discoveries in regard to the use of substitutes for imported materials made under this pressure of war needs will prove of permanent value and have a permanent influence on international trade.

A conference will shortly be held between a committee of the recently formed chemical engineering group of the Society of Chemical Industry of Great Britain and the sub-committee of the council of the society to discuss the relations to exist between the two bodies in the future.

The organization has been formed principally through the efforts of Prof. J. W. Hinchley. Prof. Hinchley in promoting this new organization, expressed himself as believing that the whole chemical industry would benefit as the result of the formation of such an organization as it would serve to indicate the great advancement in the field of chemical engineering.

The Future of Chemistry

(*Continued from page 424.*)

Co-operative effort, one of the most striking aspects of modern life, only became possible when science provided the facilities for municipal power schemes, for telegraphic connection over the whole world, and for the cencentration of production in definite centres. Chemical science is still furnishing the means for further revolutionary changes; during the last few years we have seen great technical developments of purely scientific discoveries—the work of Dewar on the liquification of gases, and that of Cross and Beven on viscose and artificial silk, both of which have led to the profitable utilization of vast amounts of capital—and it is as yet impossible to indicate the ameliorations of the conditions of human life which will inevitably result from contemporary chemical investigation.

In a time of crisis like the present, British custom tends towards the replacement of unreal convention by what is really vital; we have been engaged upon this operation for several years. Whilst previously unheard-of changes have succeeded each other kaleidoscopically in the national constitution, in the political parties in power, in the freedom of the subject, and in hosts of other ways, the nation has recognized that science is the only real maker of history. The whole Empire is now one vast chemical and engineering laboratory, and we even live on a scientific ration of so many calorific units. It is obvious that chemistry, with physics, engineering, preventive medicine, and others of the natural sciences, which previously had no imperialistic position, because powerless to make or break a government, have become the pivot on which turn all our hopes of retaining an independent national existence; it has been suddenly realized that supremacy in these branches of knowledge is vital to our country.

The time is approaching when this state of affairs will change; neglect of the natural sciences will then no longer put us in danger of sudden extinction, but, as was taking place years ago, will lead to our slow certain downfall as a nation. The responsibility is placed upon our scientific men of taking such measures as will ensure that the old order is not re-established, that science makes her voice heard in our national councils, and that policies of drift are forever abandoned.

We have in this country three large and long-established organizetions devoted to various phases of chemical science: the Chemical Society, the Society of Chemical Industry, and the Institute of Chemistry. Is it too much to ask that these three representative bodies, with perhaps the newly-founded Association of British Chemical Manufacturers, and ultimately all the other cognate but more specialized interests, should set up a watchful and alert joint council with directions to consider national questions in which any of the varied interests of chemistry are concerned, and to make such representations to our administrators as would voice the corporate view of the joint body.

I am inclined to think that, had such a body been in existence several years ago, much that has been accomplished in the interval by somewhat devious methods would have been better done. One instance will occur to everyone: that of the much-debated question of the re-establishment of the coal-tar color industry in Great Britain. The scheme adopted by the Government for resuscitating this phœnix in our country, after its past thirty years of profligate productivity on the Continent, was launched without scientific advice; the Cabinet mouth-piece, indeed, declared that the directors of the company was not to include men of scientific knowledge, on the ground that a director who knew something about the business of the company would have an advantage over his less well-informed colleagues.

Owing largely to the fact that we possess no strong collective council, representing the combined academic, scientific, and industrial aspects of our science and capable of representing them before a representative Government, it may be argued that we chemists are not altogether blameless for the particularly blundering way in which particular errors have been perpetrated by the responsible officials. Whilst we should be thankful that our blunders have not led to our destruction, we should proceed without further delay so to organize the resources of chemistry as to make it possible to enforce the adoption of scientific methods and modes of thought by authorities to whom these are yet strange.

The serious character of the British position in connection with the coal-tar color industry becomes more evident when one considers that this is a key industry, upon it depend the textile, paper, photographic, and pharmaceutical industries. The total capital employed in the organic dye industry in Great Britain is between four and five million pounds, whilst the capitalization of the German coal-tar color firms is of the order of fifty million pounds. The need for greater and more intelligent activity in this direction is obvious; unless national enterprise can be stimulated into providing adequately for the manifold requirements of Great Britain and her Colonies in all those industries which depend on coal-tar color manufacture, we shall be again in the hands of the foreign producer.

The control of a national dye scheme by business men with no real feeling for the enterprise on which they are engaged renders it fairly certain that the wider aspects of coal-tar color manufacture will be neglected. The interweaving of the color interests with those of synthetic pharmaceutical, photographis and other chemical industries is essential to success. The utilization and development of the resources of the Empire in natural coloring matters such as indigo is necessary from a national point of view. The careful study of our own and other codes of Patent Law in their bearings upon the fine chemical industry is also important. These weighty questions cannot receive adequate consideration from any purely lay body.

One aspect of this question, however, calls loudly for attention. For several years past our teaching staffs have been depleted, and but a small fraction of the normal number of young men have been able to present thtmselves for training in chemistry. Whilst the present demand for capable young chemists is vastly in excess of the supply, an even more serious situation awaits us in the future. If hostilities were to cease to-morrow, five years would be needed before our colleges and universities could begin to supply the large numbers of young chemists which will be required for the development of the future great chemical industry of this country.

Surely this is a matter which should engage the serious attention of the country. If it proves necessary to import young chemists from neutral nations to man our reconstruction schemes a handicap will be established which we may never outrun. The adoption of some scheme by which a sufficient number of juniors can be provided to help in the great developments which the future has in store for the scientific industries of the country is of the utmost importance.

Chemists Must Co-operate More.

It is impossible to reflect on the desirability of a closer co-operation between the large societies representing chemistry in Great Britain without foreseeing many directions in which such a union would be of value. As in every time of awakening, there exists at present a great feeling of unrest among the younger members of our profession; of late quite a number of propositions for the formation of new scientific societies have been promulgated, and all for the purpose of placing more power in younger hands and for ensuring to the juniors more security of advancement. The final objects of these propositions, so far as I have understood them, are entirely praiseworthy, but it is to be feared that the methods suggested for their attainment are not always such as appeal to older and more experienced people as likely to prove successful. If we chemists collectively were in possession of some more centralized organization, such an one, for example, as is represented by the Chemists' Club in New York, with facilities for hospitality, meetings, library, laboratory accommodation, and the like, no question could ever arise of the creation of a new chemical body unconnected with the main organization. A new and vigorous issue of the parent organization would shoot at appropriate intervals, and would remain contributing to the strength of the family under the original patriarchal roof. We greatly need a central home of all the chemical interests in the country, and premises several times as large as the Chemical Society rooms, to use as a club, of which every chemist in the country would be a member. The question of the necessary expansion of the library, which is occupying the earnest attention of your Council, would find an easy solution in such a pooling of interests.

Notwithstanding that, during the past forty years, much has been done to facilitate the entrance of talented and promising young men into the scientific professions, far more progress must be made in this direction if we are to regain for Great Britain the paramount position she once held in scientific discovery. The Natural Science Department in every university in the country call for expansion in personnel, laboratory space, and equipment, and in provision for post-graduate research work; whilst scholarships for students in training are fairly plentiful, the difficulties which face the advanced student who needs to spend, and who would benefit immensely by spending, several years on original research, are often insurmountable. Every professor of chemistry in the country can recall many instances in which he has had to send his students into technical life at too early a period, simply because it has been impossible to secure for a good man the £150 or £200 per annum necessary for living expenses; the provision of this small sum would, in many cases, convert a half-trained chemist into a far greater asset to the State.

Scientists Must Be Better Paid.

The fact emerges that if science is to retain in its service such a proportion of the most powerful intellectual and creative talent of the Empire as will suffice for our progress as a nation, some method must be devised for securing to its followers appropriate emoluments commensurate with those now allocated to the non-productive profesions.

This is not only necessary in connection with those purely utilitarian branches of chemical science to which I have already directed attention, perhaps too insistently for illustrative purposes. A great danger exists at present, and will grow in the futre, that the enormous productiveness of experimental science will overshadow the importance of scientific work of less immediate utility. It would be a great calamity if pure science were neglected in favor of the cultivation only of natural knowledge which gave immediate promise of beneficial material results. One of the most important functions of any expression of collective chemical interests such as I have foreshadowed would be to ensure that pure unproductive scientific research should be retained on an even higher level than that assigned to immediately productive original investigation.

At the present time, physics and chemistry are merging into one; we foresee that the near future will furnish us with still broader views of the universe and will mark a new development more illuminating even than the great advances followed Dalton's atomic theory and all its nineteenth century sequences. No material interests must be allowed to check this stupendous expansion of our knowledge.

The White Tar Aniline Corporation has been incorporated with a capitalization of $100,000. The incorporators are A. A. Haase, Montclair, N. J., J. J. Scheuch, 610 116th street, Manhattan, L. S. Landers, 15 Fort Washington avenue, Manhattan.

Ultra Violet Light

(*Continued from page 426*)

The light absorption of the acid and of the salt is also unaffected by changes of temperature. The solvent does not appear to exercise any influence on the absorption in the blue and violet parts of the spectrum, but does so to a very slight extent in the green and ultra violet.

Organic Platinum Compounds.

Hantzsch (Ber., 1911, *44*, 3290) has investigated the ultra violet absorption of a number of aliphatic ammonium salts in order to determine whether these exist in valency-isomeric forms. The existence of such valency-isomerides is indicated by two modifications of dimethylammonium platinichloride. In all solvents the molecular absorption of the alkylammonium salts is independent of the concentration, so that no evidence of the existence of valency-isomerides was obtained. From the independence of the absorption and concentration, the conclusion is drawn that neither association nor disassociation has any appreciable influence on the absorption.

HYDROCARBONS.

Acetylene.

Henri and *Landau* (Compt. rend., 1913, *156*, 697) have made a study of the ultra violet absorption spectra of acetylene, first in gaseous state at the ordinary temperature under a pressure of one-tenth to one atmosphere, using a thickness of 40 cm. of gas, and secondly in alcoholic solution. The ultra violet absorption by acetylene commences approximately at the region where the solar ultra violet spectrum ends. The influence of the acetylene linking on the ultra violet absorption has been investigated by *Stark* and *Lipp* (Jahrb. Radioaktiv. Elektronik., 1913, *10*, 175; J. Chem. Soc, 1913, Abs., *104*, ii, 365) in reference to dipropargyl and acetylene. The extinction curve for dipropargyl shows two well developed bands, the first of which has its head at $\lambda = 245\ \mu\mu$ and the second at $\lambda = 201\ \mu\mu$. The second band is much deeper than the first. It is supposed that the two bands correspond with the pair which have been found to be characteristic of the asymmetric thylene linking. The absorption curve for acetylene exhibits a large number of narrow bands in the region of the second dipropargyl band, the intensity of which increases as the wavelength diminishes. As in the case of ethylene, these narrow bands are only obtained at comparatively high pressures.

Massol and *Faucon* (Compt. rend., 1914, 159, 314; J. Chem. Soc., 1914, Abs., *106*, ii, 695) have examined three specimens of carbon tetrachloride having respectively b.p. 76.2°/762.4mm., 76°/758mm., 76.7°/760mm. Of these, the first two specimens gave broad absorption bands in the ultra violet, while the third showed no absorption band. This specimen was submitted to fractional distillation, and a number of fractions were obtained boiling from 61.4° to 76.3°, all of which showed no absorption band. A final frac-

(*Continued on page 437*)

Growth of Dyestuffs

(*Continued from page 412*)

Speaking of the development of the American dyestuff industry since the beginning of the war in Europe, Dr. Herty said that five dyestuff plants were now engaged in making poison gas for the Government while many others were in various ways contributing indirectly to the manufacture of gas.

Dr. Herty referred in scathing terms to those merchants who still persist in using placards on their goods reading "The color of these goods cannot be guaranteed." It had never been the habit to guarantee all colors, and a great many colors did not need to be fast. Such signs were really lending aid and comfort to the enemy because they, at least, by implication, cast reflections upon the ability of American chemists and manufacturers to turn out dyes which were the equal of the German-made article.

"Assurance of the future of the coal tar chemical industry lies not only with our people as a whole," said the speaker later in his address, "but even more directly with their representatives in Congress, for it must not be forgotten that legislation stands today as a result of the enactment of the 1916 general revenue bill, which is directly in favor of the German industry."

This situation would be remedied, however, Dr. Herty believed, when the forthcoming report of the Tariff Commission on the American dyestuff industry was presented to Congress.

One point the speaker specially emphasized in connection with the question of proper tariff protection for the American dyestuff industry, was the fact that at present, according to the present schedules, intermediates were assessed at one-half the value of finished dyes. Experience, he said, had shown that this differentation was a mistake. The difficult stage of production was from the crudes to the intermediates far more difficult than from the intermediates to the finished dyes.

"And it is in the field of intermediates that dyestuffs, high explosive and medicinals meet upon common ground," continued Dr. Herty. "Furthermore it is evident that when these industries bear the brunt of foreign attack the enemy will take advantage of questions of definition to avoid the higher duties or to seek to achieve the same purpose by shipping the lower assessed intermediates for assemblage here into finished dyes by simple processes requiring little outlay.

"Knowing where the attack will be made, would it not be the part of wisdom to strengthen our forces at this point by legislation which will place all of these products on the same dutiable basis."

Searles Lake Basin

In the course of a detailed description of not only the topography of the Searles Lake Basin, but of the methods used by the American Trona Corporation to extract potash from the saline waters of the lake, Alfred de Ropp, Jr., research engineer for the corporation, said that the America Trona Corporation is producing about 1,800 tons of crude potash per month from this source. By the end of the current month, thanks to the installation of new equipment devised under the direction of Dr. H. W. Morse, the corporation will be able to turn out about 4,500 tons per month. This product will analyze from 75 to 80 per cent. potassium chloride and will contain less than 3.5 per cent. borax, figured as anhydrous sodium tetraborate. By the first of January, 1919, Mr. de Ropp said the company would be producing some forty to fifty tons of refined borax, thanks to installation of new equipment.

DU PONT AMERICAN INDUSTRIES

DU PONT DYESTUFFS

Explosives to Dyes

The evolution from explosives to dyes is the logical development of the dyestuff industry from both a chemical and engineering standpoint. The manufacturer of explosives enters upon the production of coal tar dyestuffs with these important advantages:

First, the explosives manufacturer starts with the necessary raw materials. In his munitions plants he produces the bases which are required. The immense output of his acid plants is at his disposal. In his chemical factories he manufactures many of his principal intermediates. He is therefore assured of sufficient quantities of the required ingredients—all products of this country—to meet his various needs.

He has at his command unequaled plant and laboratory facilities for the production and development of the intricate by-products of the coking industry, equally useful in the making of military high explosives and in the manufacture of dye intermediates and dye-stuffs.

His chemical and engineering organization has had long training in the closely related explosives industry and is able through the experience gained, to overcome difficulties which would be insuperable to others less fortunately situated.

The high quality of his raw materials is guaranteed because they are made under his constant supervision and control and under the very exacting requirements of the explosive industry. He is consequently able to maintain, as no other manufacturer, the high standard of his finished product. As the world's largest manufacturer of explosives the Du Pont Company enjoys these advantages to an unusual degree. It has already made possible the laying of a broad and secure foundation and the development of dyestuffs of the greatest commercial and industrial importance. It is the strongest guarantee of the permanency of our undertaking and of the final emancipation of the dyestuff industry from foreign domination.

E. I. du Pont de Nemours & Co.

Dyestuff Sales Department

Wilmington, De'aware

The Du Pont American Industries Are:

E. I. du Pont de Nemours & Co., Wilmington, Delaware, Explosives
Du Pont Chemical Works, New York, N. Y., Pyroxylin and Coal Tar Chemicals
Du Pont Fabrikoid Co., Wilmington, Delaware, Leather Substitutes
The Arlington Works, New York, N. Y., Ivory Py-ra-lin and Cleanable Collars
Harrison Works, Philadelphia, Pa., Paints, Pigments, Acids and Chemicals
Du Pont Dye Works, Wilmington, Delaware, Coal Tar Dyestuffs

DU PONT

CROSS INDEX OF TERMS

(*Continued from page* 416)

Calx Extincta—See Calcium Hydroxide.
Calx Vismuthi—See Basic Bismuth Nitrate.
Cake Alum—See Aluminum Sulfate.
Capillary Pyrites—See Nickel Sulfide.
Caustic—See Sodium Hydroxide.
Caustic Antimony—See Antimony Chloride.
Caustic Baryta—See Barium Hydroxide, also Barium Oxide.
Caustic Potash—See Potasium Hydroxide.
Caustic Soda—See Sodium Hydroxide.
Ceruse—See Lead Carbonate.
Cerussite—See Lead Carbonate.
Chili Saltpetre—See Sodium Nitrate.
Chloralum—See Aluminum Chloride.
Chlorinated Lime—See Calcium Hypochlorite.

ANALYTICAL AND CONSULTING CHEMIST
MATERIALS ANALYZED—RESEARCH WORK.
FACTORY PROCESSES INVESTIGATED.
FRED'K J. AUSTIN, 119 Nassau St., N. Y. C.

CHEMICAL MAGAZINES
BACK COPIES OF DOMESTIC AND FOREIGN PERIODICALS FOR SALE. WE BUY SETS, VOLUMES, AND NUMBERS.
B. LOGIN and SON
152 EAST 23rd STREET, NEW YORK CITY

CHEMICALS
COLORS
MINERALS

For the following Trades:
RUBBER
PAINT
TEXTILE
POTTERY
OIL CLOTH
PAPER
PRINTING INK
LEATHER

KATZENBACH & BULLOCK CO.
New York Trenton Chicago
Boston San Francisco

NEW PUBLICATIONS

The Lillie Evaporator for Waste Waters

The first booklet relating to the Lillie Evaporator, published by the Wheeler Condenser & Engineering Co., Carteret, N. J., is off the press. The Lillie Evaporator is now manufactured exclusively by this company under agreement with the Sugar Apparatus Mfg. Co., S. Morris Lillie, president, owners of the Lillie patents.

This new booklet calls attention to the factors which make the Lillie Multiple Effect Vapor Reversing Evaporator especially suited to the concentration of waste waters or liquors in numerous industries. Waste waters are often very dilute and the valuable solids form but a small per cent. of their substance. Some of these products have abnormally high values during these war times, and economy of evaporation is now of so great moment. But in normal times financial success or failure may depend largely upon economy of evaporation and it is the normal condition that should be kept in mind. The booklet discusses the "Economy Possibilities" of the Lillie Evaporator, explains the method of "Film Evaporation" discusses the effect of the Lillie Multiple Effect in bringing solutions to "High Densities," explains why "delicate" solutions are less susceptible to injury by heat in the Lillie Evaporator, tells how the vapor reversing feature reduces "Incrustation Troubles" to the minimum, refers to the economical "Distillation" of water and lastly, mentions some of the solutions that are not waste waters, but which are successfully handled by Lillie Multiple Effects. Five pages of the booklet are devoted to tables that are of especial value in the evaporation industry. An accordian folding page insert gives the principle instructions for operating Lillie Quadruple Effects.

Centrifugal Boiler Feed Pumps

In a pamphlet entitled "Centrifugal Boiler Feed Pumps," the De Laval Steam Turbine Co., Trenton, N. J., describes the De Laval combined steam turbine and centrifugal boiler feed pump. Centrifugal pumps have been used for feeding high-pressure steam boilers for a number of years, but the machine here described differs from those previously used in that the steam turbine rotor and the pump impellers are mounted upon one shaft with only two bearings and are enclosed within one housing. The combined turbine pump casing is split horizontally and by lifting the cover all internal and working parts are exposed. The steam and water connections are in the lower part of the casing and are thus not disturbed when the pump is opened. The turbine is of the velocity-stage type and the pump contains either two or three impellers, according to the boiler pressure.

One of the most remarkable features is the extremely small size and weight of this type of pump. A pump for 3,000 boiler horse power occupies a floor space of only two by three feet as against about eight times that space for an ordinary duplex pump. Turbine-driven centrifugal pumps in one housing are made in capacities from 2,000 to 10,000 boiler horse power. For larger units up to 60,000 horse power the pump and turbine are built separately, but mounted upon a common base plate. The pamphlet also describes electric motor-driven units.

USING NEW CELLULOSE YARN

(*Continued from page* 417)

and cotton necessary for the mixture we shall undoubtedly be able to get these from other sources of production."

That some at least of these obstacles to the free manufacture of cellulose yarn, by German textile mills, have apparently already been removed, may be presumed from an extract from the *Rheinisch-Westfalischen Zeitung,* quoted in the Commerce Reports of the Bureau of Domestic and Foreign Commerce. This statement reads:

"The negotiations between the Government clothing department and the Vereinigten Glantstoff factories in Eberfeld seem finally to be coming to an end. The factories have declared themselves willing to give free their patent rights for the manufacture of cellulose yarn. This will probably mean that several hundred textile factories in Saxony, Thuringen, Silesia and Rhineland Westphalia without any technical difficulties or changes will be able to weave this new yarn. This will relieve the shortage of material. It is hoped that in a short time it will be possible to push the manufacture so much that large quantities of cellulose yarn will be ready this fall to hand to the weaving mills."

The Century Chemical Company has been incorporated under the laws of Delaware by F. D. Buck, M. A. Davis and J. D. Frick of Wilmington.

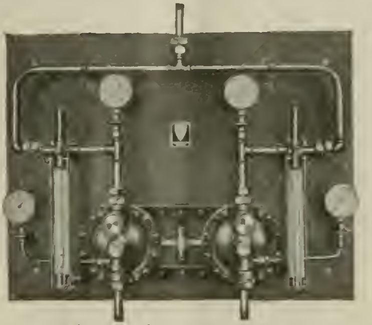
* * *

Rogers, Brown & Company, importers and exporters, announce their affiliation with A. R. Hilliard of Seattle, Wash., Mr. Hilliard to take the title of assistant sales manager.

* * *

The Florida Fertilizer Milling Company has been incorporated with a capital of $100,000. The incorporators are F. D. M. Strachan, Brunswick, Ga.; George F. Armstrong, Savannah, Ga.; Clarence Camp and Jack Camp, Osceola, Fla.

The Control of Gases



We are specialists in the control, measurement, application and proportioning of gases. The cut above shows one type of equipment developed to combine in predetermined proportion two gases of totally different properties.

W & T EQUIPMENT
For Gas Control

is constructed with the same care and attention to minute detail that has distinguished "W & T" Chlorine Control Apparatus for Water and Sewage Purification.

Our Engineering Staff is prepared for Consultation on problems of Gas Control.

Wallace & Tiernan Co., Inc.
137 Centre Street
New York City

C. L. PARKER
Chemical Patents
TRADE-MARKS
UNFAIR COMPETITION
McGill Building, Washington, D. C.

BECKMANNS
THERMOMETERS
NORMAL, ALLIHN'S & ANSCHUTZ
Gottwik, Scheffer & Co.
25 Church Street, NEW YORK
HYDROMETERS
CALORIMETER

New Jersey Testing Laboratories

Operate extensive experimental plant for trying out new processes on the large scale. Special arrangements made for the demonstration and commercial development of chemical products and processes.

92-98 Greenwood Avenue MONTCLAIR, N. J.

ANY SIZE OR SPECIFICATION

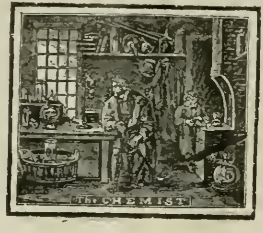
Three factories, situated in the East, Middle West and Pacific Coast, enable us to give you special service in the manufacture of tanks.

We have on hand reserve supplies of air-dried woods suited for the different chemical requirements, making prompt shipments possible.

Our many years' experience in handling tanks to standard and special specifications should be of value to you. Your specifications will have our immediate and careful attention.

ACME TANK COMPANY
37 Cortlandt Street, New York City Telephone: Cortlandt 2520

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL



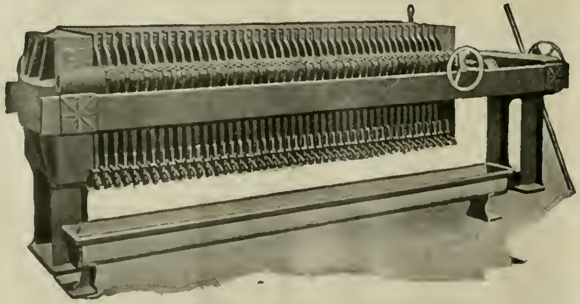
Any commercial product reproduced.

FOR
MANUFACTURERS
AND CHEMISTS

ALL questions, materials for analysis, or letters leading to the opening of negotiations for special chemical research work, will receive prompt attention if addressed to—

DR. CHARLES B. DAVIS
469 West 152nd Street
New York City

Shriver Filter Presses
FOR ALL PURPOSES



SIDE FEED FILTER PRESS

FILTER PRESS PUMPS
FILTER CLOTH AND PAPER

SEND FOR CATALOG "B"

T. SHRIVER & COMPANY
Office and Works: 812 Hamilton Street HARRISON, NEW JERSEY

ULTRA VIOLET LIGHT

(*Continued from page* 432)

tion was obtained, b.p. 76.4°/758mm., which gave no absorption band, and was shown to be pure carbon tetrachloride. The others contained carbon disulphide as an impurity, and this produced the absorption band. Neither chloroform nor dichloromethane gave absorption bands in the ultra violet. All three chloro derivatives are colorless, and transparent to the visible and ultra violet rays, only absorbing the rays of very short wave-length. The transparency for the latter rays diminishes as the number of chlorine atoms in the molecule increases.

Benzene, Toluene and Xylene.

An examination has been made by *Kowalski* and *Banasinski* (Arch. Sci. phys. nat., 1912, (iv) 34, 216; J. Chem. Soc., 1912, Abs. 102, ii., 1019) of the absorption of light by ethyl alcohol solutions of aromatic hydrocarbons in the region $\lambda = 210$ to $\lambda = 800$ $\mu\mu$, and at temperatures ranging from —190° to 15°. In the case of benzene, the photographic records show the existence of fifteen bands which may be classified in three groups. The principal group consists of six bands which are equally well defined over the entire range of temperature. The second group consists of two bands, only one of which is seen easily at room temperature, while the second band only is observed at — 190°. The third group of seven bands is found at 190°, but traces only are visible at 15°. The bands given by toluene are more sharply defined at —190° than at the ordinary temperature, and two groups may be distinguished, each of which is characterised by an approximately constant difference between the frequencies of the successive members. At the low temperature the bands are slightly displaced towards the ultra violet end. The absorption spectra of the three isomeric xylenes have also been observed.

(See also Baly, Phil. Mag. 1915, *vi,* 29, 223, who considers the ultra violet absorption spectrum of benzene, toluene, o, m and p xylene and napthalene.)

Toluene.

The absorption spectrum of toluene has been examined by *Cremer* (Zeitsch. wiss. Photochem., 1912, *10,* 349) in the form of vapor at different temperatures and in ethyl alcohol solutions of varying strength. The spectrum of the vapor consists of a series of bands extending from $\lambda = 235$ to $\lambda = 273$ $\mu\mu$, which are shaded off towards the red. The solution spectrum is also banded and the head of the bands are quite independent of the thickness of the absorbing layer and its concentration.

New N. J. Chemical Works.

At Butler, N. J., the Morris County Chemical Works has been incorporated with a capital of $100,000 to operate a plant for the manufacture of chemicals. Incorporators are John A. Marszalek, Thomas L. Sexmith, Wm. Joyce and Walter A. Clark, Butler.

available in your own Laboratory

Every Chemical Laboratory should be equipped with a source of Ultra Violet Rays.

The R. U. V. Ultra Violet Ray Lamp is especially recommended to those chemists who have failed to get desired results with the ordinary form of lamp.

POINTS OF SUPERIORITY OF R. U. V.

As an indication of its superiority, it has been proven that the R. U. V. Lamp yields twice the usual ultra violet component.

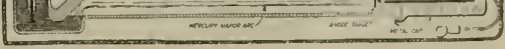
The increased radiation insures rapid developments of possible reactions.

The lamp is adaptable to various kinds of vessels. High efficiency is assured by manufacture of frame from new and clear quartz exclusively.

There is perfect electrical control.

THE R. U. V. CO., Inc.

NEW YORK CITY



Hugo Mock *Asher Blum*

Mock & Blum

PATENTS AND TRADE MARKS

CHEMICAL PATENTS A SPECIALTY

220 BROADWAY
NEW YORK CITY

RICHE' ADIABATIC CALORIMETER

Renders exact determinations of caloric and combustion contents. Sold by first class dealers of laboratory supplies. We will gladly send catalog. We also manufacture light machinery, interchangeable parts, stampings, etc., on special order.

Merit Machine Manufacturing Corporation

465 Greenwich Street, New York

B. JURIST, Chemical Director
Formerly with N. Y. Dept. of Health

PHONE: BARCLAY 6987

Research Laboratories, Incorporated

19 PARK PLACE, NEW YORK
CONSULTING and ANALYTICAL CHEMISTS
CONSULTING SANITARIANS

CHEMICAL and BACTERIOLOGICAL EXAMINATIONS
SANITARY and INDUSTRIAL INVESTIGATIONS

DESIGNS FOR CHEMICAL BUILDINGS

AND COMPLETE EQUIPMENTS
MILL ENGINEER

Frank Sutton

80 BROADWAY, N. Y. C.

Established 1897 Tel. Rector 960

The Reed Laboratories

RESEARCH AND ANALYTICAL
SPECIALIZING IN LEATHER
TANNING AND DYEING MATERIAL

227 Fulton Street, New York, N. Y.

Remember the Name

"ABERDEEN"

FOR YOUR REQUIREMENTS ON

Industrial and Textile
Chemicals, Dyes and Oils

Glucose, Caustic Soda, Soda Ash (bags and barrels),
Bichromates, Benzoates, Saccharine
U. S. Food Administration License No. G 118,579

ABERDEEN CHEMICAL CO.
200 Broadway, New York City
Telephone: Cortlandt 1127-1128

Foreign Trade Opportunities

Further information can be obtained by addressing the U. S. Bureau of Foreign and Domestic Commerce, Washington, D. C. Write each application on separate sheet.

Petroleum, Benzine, Gasoline.

26344.—A wholesale dealer in Switzerland is in the market for petroleum, benzine, gasoline and lubricating oils in large quantities. References. Correspondence should be in French or Italian.

Unvulcanized Rubber.

26486.—A man in Switzerland desires to purchase unvulcanized rubber in plates for use in manufacturing rubber stamps, rubber rings for beer bottles, and other rubber goods. Samples of stamp rubber should be submitted. Payment will be made in 30 days or by cash. Correspondence should be in French. References.

Glass and Porcelain Ware.

26309.—An American, acting as manufacturer's agent, and with an established selling organization in Central America, who is now in this country, desires representation for large factories of enamel ware, glassware, and porcelain ware. He is prepared to finance shipments and attend to details of shipping. References.

Tar and Pitch.

26467.—A company in Ireland is in the market for tar and pitch. The tar is to be used in the manufacture of tarred ropes and the pitch in connection with the felt industry.

Miscellaneous Silks.

26560.—A man in Portugal desires to purchase white, black, and colored artificial twisted silk; silk for manufacture of braids, laces, etc.; natural silk; raw China silk; silk waste; silk yarn for embroideries; silk thread; silk embroideries, knittings, fringes, etc.; Washable oriental silk; silk ribbons of all kinds; and other silk goods. Quotations may be made f. o. b. United States port, with approximate freight and insurance rates. Payment will be made by cash against shipping documents in Lisbon or New York through the medium of a bank. Correspondence may be in English. References.

Scientific Instruments.

26555.—A French company in Chile is in the market for drawing compasses in cases with one compass $6\frac{1}{4}$-inch fixed needle and pen point and two of 4[illegible] inches, three hairspring dividers, three steel-spring dividers, four drawing pens, and one improved curve [illegible] als[illegible] proportional dividers, hairspring dividers, [illegible] pens, drop-spring bow pen, beam compass [illegible] pens, and compasses with pivot joint.

Chemically Pure

LABORATORY REAGENTS

Chemically Pure

ACIDS

Hydrochloric Acid, sp. gr. 1.19
Sulphuric Acid, sp. gr. 1.84
Nitric Acid, sp. gr. 1.42
Acetic Acid, 99.5%

Ammonia Water

sp. gr. 0.90

WE manufacture and carry in stock a full line of Chemically Pure analytical reagents. These reagents do not require preliminary testing, and the results obtained by their use are accurate.

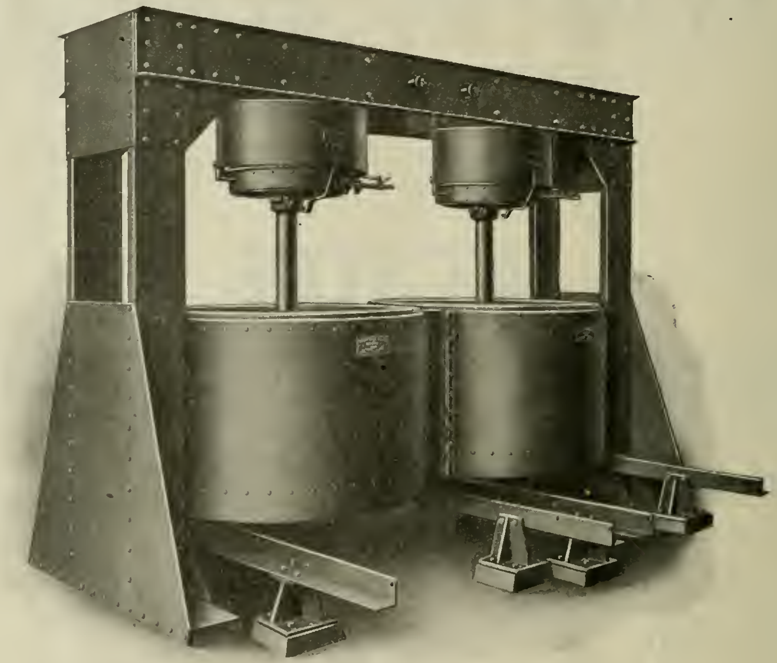
Our Products will be furnished by the leading Supply Houses, if B. & A. Chemicals are specified on orders.

LIST FURNISHED ON REQUEST

The
Baker & Adamson Chemical Company

EASTON, PENNA.

Centrifugals
FOR THE CHEMICAL INDUSTRY



The above illustration shows two of our latest improved 42-inch specially designed standard Weston Centrifugal Machines for service in the manufacture of Explosives and Sulphate of Ammonia (coke oven by-product).

We specialize in direct connected, electric motor-driven water- and belt-driven centrifugals. They are designed with a minimum number of parts and are of simple and rugged construction with few lubrication points. Sizes from 30 inches to 72 inches in diameter.

Complete specifications on request.

UNITED STATES & CUBAN ALLIED WORKS ENGINEERING CORPORATION

NEW YORK OFFICE
50 Broad Street

Factories
BRADFORD, Pa HAVANA, Cuba

HAVANA OFFICE
Cuba 84

LIQUID SULPHUR DIOXIDE

MADE BY

VIRGINIA SMELTING CO.

SOLD BY

CHAS. F. GARRIGUES COMPANY

ALSO MANUFACTURERS' AGENTS FOR

CAUSTIC POTASH, FIRST SORTS—88/92% LIQUID, 45° BÉ., AND USP STICKS—BARIUM BINOXIDE—BARIUM CARBONATE—STEARATE OF ZINC—TRISODIUM PHOSPHATE—STEARIC ACID.

80 MAIDEN LANE, NEW YORK CITY

C.P.N. CHEMICAL CO.
Covers the Country
"We Serve and Save"

EXCLUSIVE SALES AGENTS FOR

NEVIN CHEMICAL CO.

St. Louis, Mo.

MANUFACTURERS OF

- Barium Binoxide
- Barium Oxide
- Barium Sulphide
- Barium Nitrate
- Barium Carbonate
- Barium Chloride
- Barium Sulphate, Dry and Pulp
- Sodium Sulphide 60/62
- Sodium Nitrite 99%
- Sodium Nitrate Ref.

C P N CHEMICAL CO., Inc.

Department O

Industrial Chemicals

80 Reade St. New York — 227 W. Huron St. Chicago — Chemical Bldg. St. Louis, Mo.

Rector Chemical Co., Inc.

Office, 2 Rector St.,
NEW YORK CITY

Manufacturers of

METOL (Rector)
PARA AMIDO PHENOL HYDROCHLORIDE

and other photographic chemicals and intermediates.

Distributors of

PARA NITRO PHENOL
ORTHO NITRO PHENOL
PHTHALIC ANHYDRIDE
PARAPHENYLENEDIAMINE

and other chemicals.

We are equipped for blowing, grinding, engraving and experimental work. Before placing your next order for

Chemical Apparatus

Glassware, thermometers, hydrometers

Let Us Give You Our Prices!

We are also manufacturers of metal apparatus and instruments. Write us at once. Work according to blueprints our specialty.

Telephone: Stuyvesant 5439

Scientific Utilities Co., Inc.
84 East 10th St New York.

IS THERE ANYTHING IN THE LINE OF

Chemical Glassware

THAT YOU HAD TROUBLE IN GETTING?

TRY THE

Rudich Scientific Apparatus Co.
37 West 20th St., New York City

SOME OF OUR

SPECIALTIES

Graduated Ware to meet the specifications of the Bureau of Standards.

All kinds of Gas Apparatus.

Specific Gravity Bottles with Thermometer and without.

Automatic Burettes, Volumetric Flasks, Separatory Funnels, etc.

A trial order will convince you of our good quality of merchandise.

PROMPT SERVICE AND REASONABLE PRICES

WE have no corner on Chemical Stoneware quality, yet we have it cornered—backed into a tight place where it can't get away from us—at bay.

In other words, we have put the kibosh on mere cost. The price you pay for General Ceramics ware is fair price, based on the very best Chemical Stoneware that anyone in all the world has ever been able to make.

That's what you get when you order G. C. Ware. You also get prompt action, and in case your order is large, you are enabled to draw upon the enormous facilities of our big plant.

General Ceramics Company
50 Church St., New York City

Western Sales Office: 112 W. Adams St., Chicago

See our exhibit at the Fourth National Exposition of Chemical Industries, Grand Central Palace, week of September 23rd.

Cornered!

Alphabetical Index to Advertisers

(Classified Index on Page 470)

Abbe Engineering Company.......... 475
Acme Tank Company.......... 468
Arkell Safety Bag Company.......... 472
Austin, Frederick J. Austin.......... 471

Baker and Adamson Chemical Company.......... 479
Baker Chemical Company, J. T.......... 477
Beach-Russ Company 475
Beseler Oxygen Company.......... 472
Brenner & Company.......... 482

C. P. N. Chemical Company, Inc.......... 441

Davis, Charles B.......... 476
Detroit Heating & Lighting Company.......... 472
Dupont de Nemours, E. I., Company.......... 467

Garriques Company, Charles F.......... 441
General Ceramics Company.......... 443
Gilbert Laboratories.......... 482
Gottwik, Scheffer & Co.......... 468

Hart & Company, B. Franklin, Jr.......... 482

Jacoby, Henry E., M. E.......... 482
Johnston Company, John.......... 478

Kaltenbach & Bullock Co.......... 474
Knight, Maurice A.......... 481

Login, B., and Son.......... 471
Lungwitz, Emil E.......... 444

Merit Machine Manufacturing Company.......... 471
Metallurgical Chemicals Corporation.......... 443
Metz & Company, Inc., H. A.......... 474
Mock & Blum.......... 471

National Aniline and Dye Company.......... 446
New Jersey Testing Laboratories.......... 468
New Jersey Zinc Company.......... 445

Parker, C. L.......... 468
Provost Engineering Company.......... 475

Rector Chemical Company, Inc.......... 441
Reed Laboratories.......... 471
Research Laboratories.......... 471
Reuche & Company, L.......... 474
Richard, M. W.......... 474
Rudich Scientific Apparatus Company.......... 442
R. U. V. Company, Inc.......... 473

Sarco Company, Inc.......... 472
Scientific Utilities Company.......... 442
Shriver & Company, T.......... 476
Sidio Company of America, Inc.......... 478
Simmons Company, John.......... 468
Stanley, W. W.......... 482
Sutton, Frank 471

Tirrill Gas Machine Lighting Company......Front cover

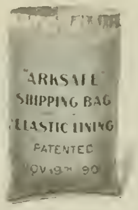
Uehling Instrument Company..........Inside front cover
United States and Cuban Allied Works Engineering Corp. 480

Van Nostrand Company, D.......... 482
Virginia Smelting Company.......... 481

Wallace & Tiernan Co., Inc.......... 472

"ARKSAFE"

Elastic Paper Linings



for Barrels and Bags

Prevent sifting and keep contents clean and dry. Used by largest manufacturers of chemicals, dyes and colors.

SEND FOR SAMPLES

ARKELL
SAFETY BAG
COMPANY

120 Broadway
New York City

THE TANK
EQUIPMENT CO., Inc.

is equipped to furnish

STEEL TANKS
for all Chemical purposes

All tanks are correctly constructed and we can make early shipments. We would be pleased to have you let us know your requirements.

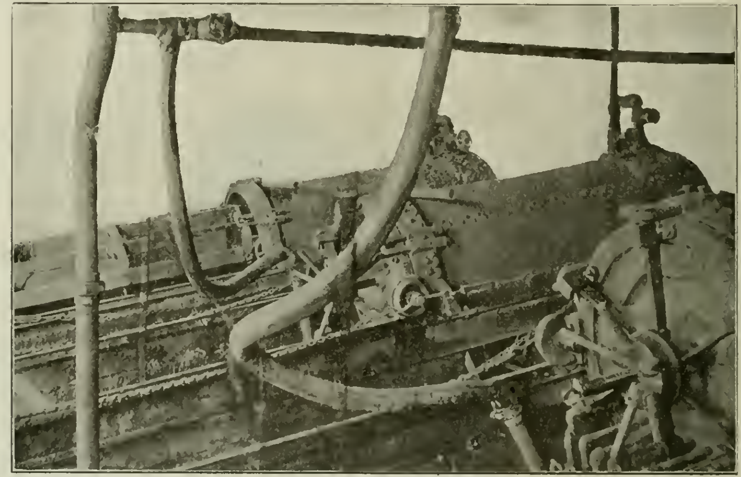
We also have some used equipment which might be of interest to you.

TANK EQUIPMENT CO., Inc.
501 Fifth Avenue
New York, N. Y.
Telephone: Murray Hill 4988-89

KELLY FILTERS

(PATENTED)

ALL PATENTS OWNED BY
UNITED FILTERS CORP., SALT LAKE CITY, UTAH



THE KELLY FILTER MADE ITS REPUTATION AS A LABOR-SAVER LONG BEFORE THIS WAR WAS THOUGHT OF; HENCE ITS POPULARITY TODAY WHEN LABOR OF ANY KIND IS DIFFICULT TO OBTAIN.

EMIL E. LUNGWITZ

LICENSEE

GENERAL AND EXCLUSIVE FOR ALL INDUSTRIES, WITH CERTAIN
EXCEPTIONS, IN ENTIRE UNITED STATES EAST OF COLORADO

90 WEST STREET, NEW YORK, N. Y.

New Jersey
zinc

The World's Standard for Zinc Products

Fineness, high metal content, brightness of surface, uniformity are all important in

zinc dust

for the cyanide process.

New Jersey Zinc Dust excels in all these qualities—conspicuously in uniformity of size and cleanness of surface.

It is different from other zinc dusts, made by a special process developed during our seventy years' experience in making zinc products.

We also manufacture Zinc Oxide, Spelter, Rolled Zinc Strips and Plates, Zinc Chloride, Lithopone, Spiegeleisen and Sulphuric Acid in all concentrations.

THE NEW JERSEY ZINC COMPANY
55 Wall Street, New York
ESTABLISHED 1848
Chicago: Mineral Point Zinc Company
1111 Marquette Building

TABLE OF CONTENTS

Editorial 447

Industries Face Future Optimistically 448
Manufacturers and Chemists tell Chemical Engineer industries can regard future hopefully.

Reconstruction Conference at Atlantic City 450
Three hundred war service committees to discuss after-war problems December 4, 5 and 6.

Coke Makers Make Nitrate of Ammonia 451
Coke manufacturers of England have met with success in turning by-product to account.
By Mark Meredith, M.E.A., M.I.S.A.

Many New Corporations Formed 452

Britain Prepared for Reconstruction 453
Annual Report of the Council for Scientific and Industrial Research indicates that considerable progress has been made in direction of preparing for peace.

Germans Must Return Stolen Property, Say Chemists 455
New York Section, Society of Chemical Industry, passes resolution demanding reparation and restitution.

Cross Index of Chemical Terms 456
By Elton R. Darling.

New Method of Chromic Oxide Determination 457
By W. C. Riddell and Esther Kittredge.

Potash Situation Growing Serious 459
United States still in spite of war developments unable to supply her own normal potash demand.
By R. C. Randall.

Ultra Violet Light—Its Application in the Chemical Arts 465
By Carleton Ellis and A. A. Wells.

The Future of the American Dyestuff Industry 467

New Publications 471

Statement of the Ownership, Management, etc., Required by the Act of Congress of August 24, 1912.

Of the Chemical Engineer, published monthly at New York, N. Y., for October 1st, 1918.
County of New York, State of New York, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Robert H. McCready, who, having been duly sworn according to law, deposes and says that he is the Publisher of the Chemical Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 21, 1912, embodied in Section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, McCready Publishing Co., 118 East 28th St., N. Y.; editor, A. G. Sclater, 118 East 28th St., N. Y.; managing editor, none; business manager, H. C. Daych, 118 East 28th St., N. Y.

2. That the owners are: C. J. O'Brien, 22 North William St., N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fudiciary relation, the name of the person or corporation for whom such trustee is acting is given: also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him. ROBERT H. McCREADY.

Sworn to and subscribed before me this 30th day of September, 1918. FREDERICK PFISTER.

(My commission expires March 30, 1919.)

Largest American Producers of

Army Khaki
for Cotton and Wool

Blues
for Navy Cloth

Diphenylamine
Dimethylaniline
Aniline Oil
Dinitrophenol
Monochlorbenzol
for Explosives

National Aniline & Chemical Company
Incorporated
Main Sales Office: 21 Burling Slip, New York

Boston
Charlotte
Chicago
Cincinnati
Hartford
Kansas City
Milwaukee
Minneapolis
Philadelphia

Back up the Boys in France—Buy W. S. S. regularly

THE CHEMICAL ENGINEER

Copyright, 1918, by McCready Publishing Company

VOL. XXVI. NOVEMBER, 1918 No. 12

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

ALEXANDER G. SCLATER,
Editor.
CHARLES B. DAVIS, F. C. S., Consulting Editor
H. C. DAYCH, Business Manager

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

NOVEMBER, 1918

SINCE its foundation seventeen years ago, it has been the aim of The Chemical Engineer to serve its readers in every way possible. Today faced as the country is by industrial and commercial problems more difficult of solution than any it has perhaps ever faced before, The Chemical Engineer feels that its opportunity for service is greater than ever. We therefore, wish to call our readers attention to the fact that our columns and our services are at their disposal at all times. So far as the use of our columns are concerned, we believe we can be of service as a medium from time to time for the expression of opinion regarding matters touching the welfare of any of the various chemical industries.

Most of our readers are either chemists or manufacturers: most of them have problems they find difficult of solution. To these we offer our services. If they will but write us a detailed account of their problems, we will do our best to put them in touch with those who can give them the best scientific advice obtainable.

THE imminent, declaration of peace will bring the fertilizer industry of the country face to face with a situation demanding careful handling on their part and on the part of the Government. Today the industry is managing to subsist on war time rations of potash, for the greater part derived from American sources. In spite of the most intensive development of all possible sources of supply, it is hardly likely that more than twenty percent of the country's normal potash requirements will be available from these sources during the coming year. As is well known the soil of many of the southern states have been seriously impoverished during the past two years, by the farmers' inability to obtain anything but low grade fertilizers with a very low potash content. It is likely that with the increased demands to be placed upon the country's agricultural resources during the next year or so, this potash famine will become increasingly serious. To enable the farmers of the United States to turn out the greatest possible amount of produce during the coming few years, where is the potash coming from?

Is the fertilizer industry of this country to acknowledge the truth of a recent expression of opinion of a chemist in the Government employ, that so far as the potash industry is concerned Germany has inherent geological and geographical advantages over the United States? And that we will be compelled in the future to look to her for a great part of our potash as we did in the past?

Granting that the fertilizer industry will be compelled in the not far distant future to resume its use of German potash, may it not be expected that a certain proportion of the distaste with which such a step will be viewed by many in this country, will be mitigated by the thought that such an action would be taken purely and simply from a desire to increase the food and raw material supplies available in the United States?

AMONG technical men almost universal approval will be expressed of the recommendation recently made by the United States Section of the International High Commission, regarding the more extensive use of the metric system in the trade and commerce of the United States. This approval will be heartily seconded by a great many American manufacturers.

Only the English speaking nations still have to adopt the metric system of measurement. With the exception of Great Britain it is universally used in Europe and Latin America long since made it official. Great Britain is believed to be seriously considering its adoption. Why not the United States?

Quite apart from the saving of time, in the internal commerce of the country, which would inevitably result after the system has been in use for some little time in this country, the adoption of the metric system would facilitate the processes of international commerce, to a remarkable degree.

Two thirds of the countries of South America have already signified their acceptance of the treaty recently signed between the republics of North and South America, making it possible to issue Pan-American patents.

Industries Face Future Optimistically

Manufacturers and Chemists Tell Chemical Engineer American Industries Can Regard Future Hopefully —War Industries Board to Issue Statement Shortly.

WHILE to the general public and a considerable proportion of the manufacturers of the country, the signing of the armistice which brought the hostilities in Europe to a close came with a suddenness almost stunning in its effect, for months back a certain far-sighted section of the business men of the country and most of the Government departments having anything to do with the regulation and control of business, have been preparing for the coming of peace. This minority, faced with the problems of the reconstruction period, did not exhibit the same degree of uncertainty in regard to the future that many did. Having faced the worst in advance, they regarded the announcement of peace with a certain degree of calmness.

Today members of the chemical and allied industries in all parts of the country, judging from communications received since the signing of the armistice by The Chemical Engineer, regard the possibilities of the future with considerable optimism. Some of these expressions of opinion are printed below.

In anticipation of peace, the Chemical Division of the War Industries Board, under the guidance of Mr. Charles H. MacDowell, has within the past few months been quietly doing a great deal of very effective work in the direction of standardizing and developing chemical manufacturing methods in this country.

In answer to our request for a statement regarding the nature and extent of this work, Mr. MacDowell writes that at the moment his division is not prepared to make a statement, although considerable work has been done. Such a statement is, however, being prepared by the heads of the various sub-divisions of his section of the War Industries Board and this will shortly be made public.

What some of the men in the chemical industries feel regarding the future is obvious from the following letters.

Thomas J. Keenan, secretary-treasurer Technical Association of Pulp and Paper Industry:

The war in Europe has opened the eyes of American pulp and paper manufacturers to the possibilities of a great expansion of effort in the production of certain kinds of pulp, paper and paper products. Already our manufacturers are suplying different grades of paper products that were formerly purchased in foreign markets, and a considerable export demand has sprung up, especially from the countries to the south of the United States and from the Allied Nations.

With the resources of raw material still available on the American continent there should be a tremendous development in the manufacture of chemical pulps, especially those made by the modified soda method known as the sulphate process which are used so extensively in the manufacture of wrapping paper and boards, not to speak of many special papers having a kraft basis. An indication of this is given in the enterprise of certain Norwegian pulp manufacturers who are now engaged in establishing plants both in this country and in Canada for the development of our pulp resources.

With the approach of peace every means possible should be taken to interest capital in the development of a strong American paper industry. If the opportunity is neglected by our people it will not be passed by others, as there is a fierce competition impending among all the countries now at war, and it is of vital importance that we should take immediate steps to insure a greater consumption of our own raw material and a corresponding increase in exports of the finished products.

Alfred D. Flinn, secretary of the Engineering Foundation:

A greater degree of co-operation is needed between chemists and other technical men qualified to conduct research work, if the country is to prepare itself to meet the problems of the coming reconstruction period.

Co-operation in industrial research is especially important in these times to chemists and all other technical men. It is also important to make the results of research available, so as to reduce wasteful duplication of work. There are approximately four hundred industrial laboratories in the United States, little and large, devoting some part of their time to research in distinction from routine tests and investigations. Many laboratories, however, and the companies supporting them, have not sufficient resources to undertake needed researches. In many of these cases co-operation within an industry or a group of kindred industries may provide sufficient resources not of funds alone, but also of technical skill, special materials, experience and equipment.

John C. Bailar, Golden, Colorado:

When the present world war cut off the supply of chemical and scientific porcelain it became necessary for our manufacturers to supply the need. Three factories were soon in the field—the Coors Pottery of Golden, Colo.; the Guernsey Company of Cambridge, Ohio, and the Ohio Pottery Company of Zanesville, Ohio. It took but a short time to demonstrate that American manufacturers could satisfactorily supply all needs.

For some years past we have excelled European manufacturers in coarser work, such as fire brick, assayers, crucibles, etc., but it was not thought possible to compete with them in the finer grades of work such as chemical porcelain, until we were forced by necessity to try it. We have demonstrated now beyond all doubt that we have the skill and the raw material to make as good ware as is made in any part of the world; and it can be safely predicted that with the coming of peace the manufacturers of the United States will not only supply the home market, but will compete with foreign manufacturers for the trade of the world.

H. Walker Wallace, Manager, General Sales Department, Virginia-Carolina Chemical Company:

We chiefly manufacture commercial fertilizers and concentrated superphosphates. Incidental thereto, we produce sulphuric acid; also other chemicals and by-products.

War necessities have required a production of sulphuric acid and other chemicals in this country considerably in excess of normal consumption. The post-war problem of utilizing the surplus will be a serious one. Domestic requirements for chemicals will doubtless be greater than heretofore, and will absorb part of the excess. Part may also be used by the fertilizer industry as a means of augmenting the production of food and other farm products that will be needed in the process of readjustment and rehabilitation.

However, there must be additional outlets for the surplus through greater development of foreign trade. The possibilities for American enterprise along this line are practically boundless. The permanency of our spuremacy will be measured by the efficiency with which we meet this situation, and nurture foreign and domestic requirements. We should lose no time in directing our diligent attention to this.

Charles A. Doremus, M.D., Ph.D., Consulting Chemist, Secretary New York Section, Societe de Chimie Industrielle:

The only true basis on which the independence of our country can rest are agriculture and manufactures. "To the promotion of these nothing tends in a higher degree than chemistry," said Thomas P. Smith, in an annual oration delivered before the Chemical Society of Philadelphia, April 11, 1798. "Our nation is now thoroughly aroused. Since pressure has been put on us we have learned lessons of efficiency impossible to forget.

"We now realize that our economic life is dependent on science. Until now our inventions have chiefly related to civil and mechanical engineering. The future holds out amazing possibilities to those who are pioneers in things essentially chemical."

A manufacturer of chemicals, who would not allow his name to be used, writing of after-war conditions, says:

A third source of war disturbances in the chemical industry has been due to the diversion of materials from their customary use to war uses. The fertilizer industry has probably made the greatest sacrifices of this sort. Sodium nitrate and ammonia are required for the manufacture of explosives in such large quantities that the amounts left for use in fertilizers has been and will be much reduced. Raw phosphate rock has of course been plentiful but the acid used in the manufacture of acid phosphate has been largely diverted to making explosives. The relatively small supplies of potash have been very high in price and normal amounts have not been available at any price. The peace readjustments may, however, be expected to bring compensation to the fertilizer industry. Large new supplies of nitrogenous fertilizer materials will be available from the new nitrogen fixation plants. The new and enlarged sulphuric acid plants must again find the chief outlet for their product in the making of fertilizers. Finally the German monopoly of the potash market is likely to be broken through the French control of Alsace and the new developments in America and Spain. It is therefore reasonable to expect a large increase in the manufacture and use of fertilizers with a resulting benefit to all producers and consumers of food.

The coming period of peace will offer to the American chemist and the American chemical engineer, an opportunity such as never lay within his reach before. If there is one thing that the present war taught our merchants and our manufacturers, it has taught them the necessity of scientific precision. The elimination of waste, whether of labor or materials has been forced upon America as a measure of national self preservation. But while the need for efficiency and economy has been learned to a great extent, the methods of attaining these two highly desirable industrial virtues has in many cases yet to be learned. It is here that the chemical engineer's opportunity lies.

Even though the war is over, the necessity for efficiency and economy still exists. For peace has come to find a world disorganized.

To Discuss Reconstruction Problems

War Service Industrial Committees Will Meet for Conference in Atlantic City

Plans for assembling at Atlantic City December 4, 5 and 6, all members of the country's more than 300 industrial war service committees for a great war emergency and reconstruction conference have been announced by the War Service Executive Committee of the Chamber of Commerce of the United States.

The meeting will bring together from 2,000 to 3,000 industrial leaders to discuss problems that have arisen with the war. National councillors of the Chamber, representing the more than 1,100 commercial and industrial organizations which comprise its membership, will meet at the same time and place.

The main purposes of the conferences will be the determination of practical methods whereby industry may cooperate still more closely with the Government through a more centralized scheme of organization. This probably can be accomplished best by the creation of a federation of all the war service committees. Questions of reconstruction, too, will be taken up.

For nearly a year the Chamber has been engaged in directing the organization of war service committees in all lines of industry to assist the Government in mobilizing most effectively the country's industries for prosecution of the war. It is evident that however far away the end of the war may be it is necessary to begin to outline a general program of organizing business for the period of reconstruction.

Single industries, acting individually, can scarcely hope to prepare for reconstruction on the scale that will be necessary and a federation of all the war service committees of all the industries will be of inestimable value in co-operating with those agencies of the Government to be created to deal with this subject.

The war service committees represent the most important and best informed body of business men ever associated for a practical and patriotic purpose and the conference therefore will be one of the most important business gatherings ever held in this country.

Certain common interests and duties that bind together all the war service committees include: War Industries—To keep efficiency and production at the highest possible point through stable labor conditions and steady flow of materials through plants, thus assuring the utmost aid in carrying out the war program of the Government. Non-War Industries—To keep plant organization and production from falling below the danger line in the face of shortage of materials, labor and transportation. Jointly—To face squarely and constructively the reconstruction period and to be ready through accurate and exhaustive study to lay before such Governmental agencies as may be created to deal with reconstruction the necessary data bearing on the subject.

Questions foremost at this time in the minds of every business man will be discussed at the conference by the best authorities that can be assembled. Speakers who already have accepted invitations to appear include Secretary of Commerce William C. Redfield, A. C. Bedford, James A. Farrell and Paul Warburg.

The conferences will include general sessions at which questions common to all industries will be taken up, sessions of committees within particular industries at which specific industrial problems will be discussed, meetings of related war service committee groups, and conferences of individual war service committees. National councillors of the Chamber of Commerce also will hold separate sessions.

The main conferences will be held on the Million-Dollar Pier.

Willard E. Case Passes Out

The recent death of Willard E. Case at his home in Auburn, N. Y., removed from the ranks of the electrochemists of the United States a figure of international importance. Descended from a long line of scientists, he devoted his life and wealth to the service of science, capping the achievements of a lifetime by handing over his splendid laboratories at Auburn, probably the finest in the country, to the service of his country when war broke out. A staff of Government electrochemists are now using the laboratories for the conduct of war research work.

In October of last year Mr. Case made what was said to have been the largest endowment in years for similar purposes to the New York Electrical Society to be known as the Case Fund, to be used for war research work in electricity.

The late Mr. Case was born in Auburn, N. Y., in 1857, the son of Theodore P. Case. He married in 1878 Miss Eva Caldwell, who with a son and daughter survive him.

To contend with a growing shortage of nitroglycerin explosives in South Africa, Kynoch, Ltd., have evolved at their Umbintwini, Natal, factory, a new explosive known as sengite. This new material has a gun cotton base and made by the manufacture of tonite in which nitrate of soda is substituted for the nitrate of barium usually made use of in the manufacture of tonite. Sengite has approximately the same strength as gelignite.

Coke Makers Now Make Nitrate of Ammonia

English Research Proves That It Is Commercially Possible to Turn Ammonia By-Product of Coke Ovens Into Nitrate of Ammonia.

By **MARK MEREDITH, M. E. A., M. I. S. A.**

OWING to the scarcity of sulphuric acid in the chemical world, nitre cake has been tried for mixing with acid to make sulphate of ammonia, but it is hardly suitable, because of the considerable admixture of sodium sulphate and recent research has proved that it will be possible in the future for the makers of coke to easily turn their ammonia by-product into nitrate by means of acid of their own manufacture.

The process is naturally a lengthy chemical one and needs specially designed plant, but the nitric acid required for nitrate of ammonia may be very dilute—of, say 25 per cent. to 33 per cent. strength—and it is easily and cheaply made from the air, by electric power. The process is not new, because nitric acid has been made from the air on a very large scale for many years in Norway, Italy and France, and one of the most striking scientific developments of the war has been the way in which some countries, by fixation of atmospheric hydrogen, has become entirely independent of Chili nitrate and of sulphuric acid. Atmospheric nitrogen can be made in two ways: First, as ammonia, and secondly, as nitric acid. Ammonia can be made.

(a) as a by-product in the manufacture of coke in regenerative and in waste heat ovens.
(b) as a by-product in the manufacture of lighting and heating gas, for town supply.
(c) as a by-product in the Mond process for production of power-gas from slack coal.
(d) as a by-product in the application of the Mond process to the production of power gas from peat.
(e) as a by-product in connection with distillation of bastard and lignite coals.
(f) as a direct product by acting on superheated steam on calcium cyanamide, which latter compound is obtained by combining pure nitrogen with calcium carbide.
(g) as the direct product of the synthetic combination of pure nitrogen and pure hydrogen in the presence of a catalyst by the process due to Prof. Haber.

Nitric acid can be made in any of the following ways:

(a) The action of sulphuric acid on sodium nitrate or Chili saltpetre. This method is practically universal in the British Isles.
(b) Fixation of atmospheric nitrogen by the direct process using electric arc flames. This method is employed on a very large scale in Norway, and is used in Italy, France, Switzerland. A factory is to be built in Manchester.
(c) Oxidisation of ammonia in the presence of catalyst by the process due to Prof. Ostwald. This method is employed on a large scale on the other side, and is also in use in Italy, France and Belgium. A small plant has been built at Dagenham Dock, in Essex.

The various methods of making ammonia and the nitric acid into nitrate of ammonia are briefly as follows:

1. By direct mixing of strong ammonia with strong nitric acid made from nitrate of soda. This method is employed by Chance and Hunt.

2. By the reaction of sulphate of ammonia with calcium nitrate or nitrate of soda. This method is employed by Brunner, Mond & Co.

These are purely chemical methods, whereas the two following depend upon the use of catalysts.

3. By the combination of ammonia made from calcium cynamide, with nitric acid made from the ammonia by a catalyst. This method is employed in France, and a factory has been built at Dagenham Dock, Essex.

4. By combination of ammonia made by the synthetic or Haber process, with nitric acid made from the oxidation of ammonia by a catalyst. This method is employed on a large scale in Germany.

There is finally the electrical method.

5. By direct mixing of ammonia solution. with dilute nitric acid of about 25 per cent. strength, made from air by the direct arc-flame process.

For the extension of this last method it has been proposed that gas from regenerative coke ovens or the steam raised by waste heat ovens should be utilized in an electric power house, built by the coke oven proprietor, and some, if not all, energy be employed in making nitric acid from air—this acid to be then combined with ammonia from the ovens to make nitrate of ammonia. This process can be developed at a very low cost at all existing works and its general adoption would mean increased fuel economy.

Nitrate of ammonia is the principal ingredient of most safety mining explosives, the word "safety" being a relative term expressing the fact that they are safer than dynamite, etc. On the Continental Railways, before the war, nitrate of ammonia explosives were considered so safe that they were carried at ordinary rates, but on the British railways have always charged high rates. The British and other governments have passed regulations insisting on only safety or permitted explosives being used in mines, and the more this idea extends the more nitrate of ammonia will be required. Other uses of the nitrate are in burster charges for shells, as an explosive for tree planting, and as a fertilizer.

Before the war Great Britain imported nearly all the nitrate of ammonia for making safety explosives from Norway, and peculiarly enough that country had no coal from which to obtain ammonia, so it had to be sent from England. Ammonia liquor was collected from gasworks and coke oven plants, and concentrated to bring the ammonia up to 25 per cent., and this solution was then railed to Hull, shipped in steel tanks to Skien in Norway and carried a considerable distance up country to the air nitrate factory. As the proportion of water was 75 per cent., the freight, calculated on the real ammonia in the solution was naturally high. The cost of carrying steel tanks, and the heavy depreciation of them was also a great expense, and finally the nitrate of ammonia when made was reshipped from Norway to England, a great deal of it going to Nobel's works in Ayrshire.

Since the war ammonia liquor has continued to be sent to Norway, and nitrate of ammonia brought back, but since the submarine menace this business from England has practically stopped. Ammonia is now being made in Norway by acting on calcium cynide with superheated steam in autoclaives, but the Norwegians prefer the British by-product ammonia as being cheaper.

Before the war Germany was the largest purchaser in the Chili nitrate market, taking twice as much as the next largest customer, the United States, and over six times as much as Great Britain. Now this country does not require any Chilian product, because immense plants to make nitrates from the air have been established. Great Britain, of course, is still completely dependent upon the Chilian product, and thus has to pay large sums for it, its transport and insurance, etc., while large sums are also required for the pyrites, sulphur and for the plants to manufacture sulphuric acid with which to treat the nitrate. The erection of new plants at each coke oven battery would obviate this needless expense and create another new industry, and not only in Great Britain but anywhere at all where coke oven and waste heat ovens are used.

According to the Bureau of Foreign and Domestic Commerce there is at present a good market in Algeria for dyes and dyestuffs. In normal times this market is supplied from Lyon, France. A list of the users of dyes and dyestuffs in Algiers may be obtained from the Department.

The American Chicle Company has purchased additional property adjoining the site upon which it is erecting its new laboratory for the experimental refining of gums, on Hayward Avenue, Long Island City, N. Y.

Many New Companies Formed

Incorporation Records Indicate Steady Increase in Number of Chemical Firms

The Rustanite Corporation, of Manhattan, has been incorporated with an authorized capital of $20,000. The incorporators are D. Sapperfield, W. Eisenbauer, H. P. Nelson, 550 West 157th Street.

The Dye and Chemical Manufacturing Corporation, of Manhattan, has been incorporated by W. C. Sullivan, J. C. Duke, B. B. Mead, all of 1009 Washington avenue, with an authorized capital of $100,000. The company will manufacture potassium permanganate, dyes, explosives, etc.

The Marden, Orth and Hastings Corporation is now in its quarters at 136 Liberty Street. The following allied companies have their New York offices at this address: Calco Chemical Company, United Oil and Chemical Company, Buttersup Oil and Tar Corporation, Edible Oil Company, Inc., Ruhm Phosphate Mining Company, and M. O. H. of the West Indies.

The Brooklyn Potash Company has been incorporated to manufacture chemicals, drugs and dyes, with a capital of $50,000. Those given as incorporators are O. E. Edwards, Jr., 226 76th Street; M. Kiss, 66 Wellington Street, Brooklyn; M. Scott, 173 Wood Avenue, Tottenville, N. Y.

The incorporation is announced from Trenton, N. J., of the Reduction and Concentration Corp. of Birmingham, with an authorized capital of $200,000, and a charter authorizing them to manufacture fertilizers. The incorporators are D. T. Connell, White Plains, New York, and J. F. Roach and O. I. Bahn, of New York City.

The incorporation of the Century Chemical Company, of Paterson, N. J., is announced with an authorized capital of $100,000. The incorporators are Jane D. Keller, William J. Lickel, and Franklin J. Teller, New York City.

The incorporation is announced from Albany of the Process Engineers, Inc., Manhattan, with a capital $200,000, with incorporators as follows: A. J. Kellogg, H. J. Alheim, E. Ackley, all of 15 Broad Street, New York City.

The Eby Chemical Company, Manhattan, has been incorporated with a capital of $10,000. The incorporators are A. A. Friedlander, L. and E. Greenberg, 900 Eastern Parkway, Brooklyn.

The Graham Chemical Company, Manhattan, has been incorporated with a capital of $24,000. The incorporators are P. E. Carroll, B. Kaiser, S. A. Carlson, 1566 East 13th Street, Brooklyn.

The incorporation is announced of the Persol Chemical Corporation, Buffalo, with an authorized capital of $100,000. The incorporators are as follows: L. Owitz, Carlton Court Apartments, L. A. Molin, D. Levin, all of Buffalo.

Preparations are being made by the Capote Nitrate Company, of San Antonio, Texas, recently incorporated with a capital of $100,000, to develop a large nitrate deposit located near Marfa, Texas. The backers of the new corporation are Alfred Dueler, G. C. Simpson, and J. B. Herff, all of San Antonio.

The Stockholm Superphosphate Factory A-B, according to reports from Denmark, is conducting negotiations aiming at the acquisition of the Alby Water Falls, and the Alby Carbide Factory A-B. Nearly all the shares in this latter company are owned in Great Britain. In 1914 The Alby Carbide factory turned out 8,000 tons of calcium carbide and 9,500 tons of lime.

Huns Must Return Stolen Property

New York Section of Society of Chemical Industry Passes Resolutions Demanding Replacing of All Machinery Stolen by German Army in Invaded Countries.

RESOLUTIONS demanding that the German Government be compelled to make restitution for all stolen property and machinery, on the drawing up of the final peace terms, were passed at the meeting of the New York Section of the Society of Chemical Industry held in the Chemists' Club, New York City, on the evening of Friday, October 25. During the course of the war, the German Government, the members present believed, had made systematic attempts by the removal of machinery and workmen to cripple possible industrial competitors. In justice to these competitors and in justice to the rest of the world, who would thus be threatened by a too exclusively German control of certain fields, reparation should be insisted upon.

During the course of the evening Major H. W. Dudley, of the British-American Gas Warfare Service, made an address on "Gas Warfare, Offensive and Defensive," illustrating his remarks with motion pictures of the Woolwich Arsenal, pictures of American gas mask factories and a collection of various types of gas masks.

Major Dudley's address formed a complete history of the development of gas warfare, offensive and defensive. Inaugurated by the Germans in March, 1915, at the first battle of Ypres, and adopted as a consequence by the Allies in September, 1915, the new weapon soon became of such importance, according to Major Dudley, that at one stage of the conflict on the Western front, weakness in the use of either offensive or defensive methods of gas warfare on either side would have meant defeat.

In outlining the history of the evolution of gas warfare Major Dudley said that it had developed in much the same way as the old time competition between the projectile maker and the armor plate manufacturer: the introduction of improvements on the part of one were closely followed by equally important developments on the part of the other.

First Method of Attack.

The first form in which gas was utilized was in the form of the "cloud attack." When this was first used by the Germans in 1915, pure chlorine gas was used. This was stored in cylinders, equipped with siphon tubes running through the centre. These cylinders were carried up by the infantry and placed under the parapets, until needed. To take up escaping gas these cylinders were covered with mats saturated with potassium chlorate. When an attack was to be made pipes were attached to these cylinders and run over the parapet and the gas permitted to escape.

The limitations of this method of gas attack eventually, said the speaker, led to its virtual abandonment Even with the best of discipline and equipment there were inevitably a number of casualties among the attacking troops. Then, too, there were not many gases which were suitable for use in the cylinders. It was found that a gas to be used for such a purpose must have a low boiling point, be toxic, and stable in the sense that it should be difficult for the enemy to find suitable materials to put into their defensive respirators. Then there was also the all-important condition that the gas should be obtainable in enormous quantities.

Another limitation of the gas attack was its dependence on atmospheric conditions. If any degree of success was to be achieved, the most careful weather observations were necessary. There was always the danger than even with the most careful allowance for weather condition, the conditions upon which the success of the attack depended might change at any moment.

Yet another serious limitation lay in the fact that with this method of attack the high concentration was right over your own parapet and that the concentration decreased the farther the gas had to travel.

Surprise Attack Difficult.

There was also the difficulty of obtaining a surprise attack on your enemy. It was a very easy matter for your enemy to discover that you are about to make an attack by the "cloud" method. First, all material had to be carried up. If the gas had any distance to travel the noise of the gas escaping from the cylinders gave the attackers' intentions away. This noise of escaping gas could be heard even when masked by machine gun fire.

In using gas as an offensive weapon surprise was all important, the speaker said, even more important than the two other important factors, that of having a gas which penetrated the respirators and as rapidly as possible exhausted the defensive chemicals of the enemy.

The limitations of the "cloud attack," therefore, led inevitably to the decision to place poison gas in projectiles because in this way the surprise factor was easily obtainable. Further by using projectiles the high concentration of gas was obtained exactly where you wanted it. You were further not so much at the mercy of atmospheric conditions. An additional advantage of this method of gas attack lay in the fact that a wide range of materials could be used in projectiles. It was possible to use materials with a high boiling point and in fact even poisonous solids.

The Germans very early in the war, according to

Major Dudley, began the use of poison shells. They made the first use of them in May, 1915.

There were two main types of gas shells used, first the lethal type, and second the "neutralizing" shells. The first were, of course, used to produce casualties among the enemy, and the second to destroy the morale of the troops on the opposing side. Among the Germans the lethal shells were known as the green cross shells, from the marking made on their base. These usually contained trichlormethyl chloroformate. The "neutralizing" shells, called by the Germans the "blue cross" and the "yellow cross" shells, could be classified into two divisions, according to the effects of the gases they contained as the sterntators and the lacrymators, or the sneezing and tear-producing gases.

Of the three classes of gases the lacrymator, beyond their tear producing qualities, were more or less harmless. The effects of the gas given out by the Green Cross shells were similar to that of phosgen, or the famous mustard gas.

Speaking of phosgen or mustard gas, the contents of the Yellow Cross shells, Major Dudley said that this gas had a high boiling point—over 300 degrees C. It has the advantage as compared with other gases of possessing only a slight smell and was very quick acting. Furthermore, it was at first non-irritating. These qualities made it possible by the use of this gas to take the enemy troops off their guard, as they were often deceived into believing that they did not need their gas masks when attacked. The high boiling point of this gas further made it very persistent. Mustard gas might persist in an attacked area for weeks.

Mustard gas was a very intense skin poison and raised large blisters which were very hard to cure. The lungs, the speaker said, were very sensitive to the influence of this gas.

The Germans had made use of this gas in all sizes of projectiles, from those containing only 200 cc. to those containing as much as 11 litres.

A particular useful method of placing this type of gas in the enemy trenches, according to Major Dudley, was by means of bombs thrown by trench mortars.

Speaking of the defensive methods adopted to counteract the effects of the gas attack, Major Dudley said that at first the casualties were very heavy among the Allied troops when the Germans made their attacks. All sorts of respirators were tried. Socks filled with damp earth, even wet handkerchiefs were tried, but, of course, did not prove effective. An appeal made to the women of England and France eventually resulted in the manufacture of the first crude respirators, mere bandages of various fabrics which the troops were instructed to dip before an attack in pails of chemicals. Later other designs of helmets were provided. The second official type was provided with mica windows and contained a bag filled with hypo sodium chlorate.

It soon became evident that this respirator was no protection against phosgen. A flannelette helmet was then devised, made of two layers of flannelette soaked in a solution of sodium phenate. In devising this helmet an important step was taken in the development of the respirator for this type first made use of the expiration valve. This was a great step forward, as by providing for the expulsion from the helmet of the carbon dioxide it prevented the carbonization of the chemical in which the helmets were soaked. It further permitted the helmet to be kept full of clean pure air at all times. It was, therefore, much cooler and comfortable than anything devised to that date.

This respirator had by various steps evolved into the present type of box respirator. In this respirator the poisonous gas was taken up by the contents, charcoal and an alkaline granule, of the box.

The box type of respirator, the speaker said, had two lines of defense. If the face piece was torn, the wearer could, of course, be effected by tear gas, but as his hose was clipped off his lungs were protected.

Charles E. Sholes, chairman of the New York Section, occupied the chair.

To Sell Enemy Property

Early in December it is the intention of the Alien Property Custodian, A. Mitchell Palmer, to sell stock in American German-owned corporations to the extent of $100,000,000.

These sales, which will be supervised by Joseph F. Guffey, Director of Sales of the Alien Property Custodian's Department, will include the sale of the following chemical and color companies.

The Bayer Company, New York City, December 3.
Synthetic Patents Company, New York City, December 3.
International Ultramarine Company, Ltd., New York City, December 9.
Heyden Chemical Works, Garfield, N. J., December 11.
New Brunswick Chemical Company, New Brunswick, N. J., December 18.
Bauer Chemical Company, New York City.

The Bayer Company and its products are very well known in America. It was owned by the Bayer Chemical Company of Germany. The Heyden Chemical Company formed a link in the plan of Dr. Hugo Schmidt to corner the carbolic acid market in this country and prevent the allied governments obtaining picric acid. This company was owned by the Chemische Frabrik von Heyden of Redebeul, Germany.

Britain Prepared for Reconstruction

Council for Scientific and Industrial Research Report Indicates Progress Made

LONDON.—While continuing to carry on their war activities with their accustomed vigor, British chemists and chemical organizations are at present, with signs of peace looming larger on the horizon daily, devoting not a little thought to the part which they are to play in connection with the solution of the problems which will face Great Britain at the close of the war. Among chemists the opinion is very widely held that in the industrial reconstruction that is to take place, the chemist must be given a proper and an adequate place.

As was pointed out at a recent meeting of the British Association of Chemists at Birmingham provision has been made by the Minister of Reconstruction that the employers and the workmen in the various chemical industries be systematically consulted in regard to the reconstruction proposals, but so far no effort had been made to provide the chemists of the country with a similar method of expression.

This ignoring of the industrial chemist to a great extent on the part of the Ministry of Reconstruction is no doubt due to lack of organization at present existing among the chemists of the country, as Prof. Hinchley pointed at a recent meeting of the British Association of Chemists. For while there are a number of associations of chemists organized for the purpose of educational work, there are few, if any, which aim to represent the political and economic interests of chemists as a profession.

When such an association is formed, it seems likely that one of the principal problems it will be called upon to handle will be the question of more adequate compensation for industrial chemists. Chemists in all parts of the world are notoriously underpaid, when the value of their work to industry is considered, and Great Britain is no exception to this rule.

The third annual report of the Committee of the Priory Council for Scientific and Industrial Research reveals the fact that a great deal of progress has been made in all parts of the country in organizing research. According to the report some thirty industries are doing preliminary work with this object. The woolen and worsted industries, the photographic industries, the Portland cement and the scientific instrument industries have already formed research associations, while a number of other equally important industries are rapidly bringing similar associations to completion.

While this report serves to indicate the high degree of progress made, it is distinctly pointed out that research organization has not yet reached that point where it is possible for information to be communicated from industry to industry. .

In summing up the result of its work during the year just past the council touches upon certain conclusions reached as a result of their efforts to organize research work which should prove of interest to American chemists and chemical organizations.

It is pointed out first that in attempting to organize research associations it is only possible to make any degree of progress when the members of an industry are conscious that there are a number of problems common to them all, the solution of which would be to their mutual benefit. As an illustration of what is meant by this rule, the Council instances its failure to organize the makers of all types of internal combustion engines. Similarly not much success has been experienced in the Council's attempts to organize the manufacturers of and users of refractories.

The Council seems convinced that attempts to form industrial research organizations can be attempted with any hope of success under certain fixed conditions only, conditions which take into consideration the peculiar problems of the various industries, and the peculiar circumstances which govern the conduct of each.

In bringing its report to a close the Council emphasises the need for an increased supply of research workers. The industries of the country must look to the educational system for these, the report points out, and therefore hearty commendation is expressed for the decisions recently arrived at by the committee appointed to inquire into the position of natural science in the educational system of Great Britain.

The recent reports emanating from German sources regarding the extent to which post war textile problems will be solved so far as Germany is concerned by the manufacture of cellulose yarns, are regarded with considerable scepticism among British textile chemists. While it is more or less generally acknowledged that the reports of the progress German chemists have made in the production of wool and cotton substitutes are very interesting, definite expression of opinion regarding the possibility of these new fibres replacing cotton and wool to any great extent is withheld until the cost of production is made known.

The Salters Company of London has formed the Salters Institute of Industrial Chemistry to provide research in industrial chemistry. It is the intention of the director of the new institute to make arrangements between manufacturers, universities and students for the investigation of any problems needing research and give practical advice to those intending to follow the career of industrial chemists.

Cross Index of Chemical Terms

Compiled by E. R. Darling

Second Instalment

THIS cross-index was prepared as an aid in finding true chemical names and other synonyms associated with them.

Chloride of Lime—See Calcium Hypochlorite.
Chrome Green—See Chromium Trioxide.
Chrome Yellow—See Lead Chromate.
Chromic Acid—See Chromium Trioxide.
Chromic Anhydride—See Chromium Trioxide.
Cinnabar—See Cobalt Oxide.
Common Alum—See Aluminum Sulfate.
Common Salt—See Sodium Chloride.
Concentrated Alum—See Aluminum Sulfate.
Constant White—See Barium Sulfate.
Coppras—See Ferrous Sulfate.
Crocosite—eSe Lead Chromate.
Corundum—See Aluminum Oxide.
Corrosive Sublimate—See Mercuric Chloride.
Cosmetic Bismuth—See Basic Bismuth Chloride.
Cream of Tartar—See Potassium Bitartrate.
Cremor Tartari—See Potassium Bitartrate.
Crocus of Antimony—See Antimony Sulfide.
Crocus Ferri—See Ferric Oxide.
Crocus Martis—See Ferric Oxide.
Crude Antimony—See Antimony Sulfide.
Crystal Carbonate—See Sodium Carbonate.
Cube Alum—See Aluminum Potassium Sulfate.
Cubic Nitre—See Sodium Nitrate.
Diacetate of Lime—See Calcium Acetate.
Diarsenious Disculfide—See Arsenic Disculfide.
Diaspori—See Aluminum Hydrate.
Diasotizing Salts—See Sodium Nitrate.
Diuretic Salts—See Potassium Acetate.
Deuto-joduretum Hydrargyri—See Mercuric Iodide.
Dried Alum—See Dried Potassium Aluminum Sulfate.
Electrolytic Salts—See Nickel Sulfate.
Emetic Tartar—See Antimony Potassium Tartrate.
English White—See Calcium Carbonate.
Epsom Salts—See Magnesium Sulfate.
Ethiop's Salts—See Mercury Sulfide.
Exsiccated Alum—See Dried Potassium Sulfate.
Factitious Cinnabar—See Mercuric Sulfide.
Febrigufe Salt—See Potassium Chloride.
Ferris Rubigo—See Ferric Oxide.
Ferrugo—See Ferric Oxide.
Fixed Mineral Alkali—See Sodium Carbonate.
Flake Lead—See Lead Carbonate.
Flake White—See Basic Bismuth Nitrate.
Flowers of Antimony—See Antimony Trioxide.
Flowers of Arsenic—See Arsenious Oxide.
Flowers of Zinc—See Zinc Oxide.
Fluid—Gelatine—See Aluminum Acetate.
Fluor Spar—See Calcium Fluoride
Fuming Liquor of Arsenic—See Arsenic Chloride
Gibbsite—See Aluminum Hydrate.
Glass of Antimony—See Antimony Sulfide.
Clauber's Salt—See Sodium Sulfate.
Golden Sulferet of Antimony—See Antimony Pentasulfide.
Goulard's Powder—See Lead Acetate.
Gray Antimony—See Antimony Sulfide.
Gray Oxide of Cobalt—See Cobalt Xxide.
Greenockite—See Cadmium Sulfide.
Green Vitrol—See Ferrous Sulfate.
Gypsum—See Calcium Sulfate.
Haheman's Mercury—See Ammonium Mercurous Chloride.
eavy Magnesia—See Magnesium Oxide.
Heavy Spar—See Barium Sulfate.
Heavy White—See Barium Sulfate.
Hepar Sulfar—See Potassium Sulfide.
Horn Lead—See Lead Chloride.
orn Silver—See Silver Chloride.
Hydrate of Baryta—See Barium Hydrate.
Hydrargyri Praecipitatus Alum—See Ammonium Mercuric Chloride.
Hydrargyri Supermurias—See Mercuric Chloride.
Hydrargyri Permurias—See Mercuric Chloride.
Hydrargillite—See Aluminum Hydrate.
Hydrosodic Cardonate—See Sodium Bicarbonate.
Hypantimonious Acid—See Antimony Trioxide.
Hypo—See Sodium Thiosulfate.
Hyposulfite of Soda—See Sodium Thiosulfate.
Indian Red—See Ferric Oxide.
Infusible White Precipitate—See Ammonium Mercuric Chloride.
Iron Chloride—See Ferric Chloride.
Iron Rust—See Ferric Oxide.
Iron Suboxide—See Ferrous Oxide.
Iron Vitrol—See Ferrous Sulfate.
Jaune Brilliant—See Cadminum Sulfide.
Jeweler's Rouge—See Ferric Oxide.
Kali Preaparatum—See Potassium Carbonate.
Kieserite—See Magnesium Sulfate.
King's Gold—See Arsenic Trisulfide.
Knig's Yellow—See Arsenic Trisulfide.
Lapis Caustic—See Silver Nitrate.
Lead Spar—See Lead Carbonate.
Light Magnesium Calcined—See Magnesium Oxide.
Lemon Chrome—See Barium Chromate.
Leipzic Yellow—See Lead Chromate.
Lime—See Calcium Oxide.
Limstone—See Calcium Carbonate.
Lime Water—See Calcium Hydroxide.
Liver of Antimony—See Antimony Sulfide.
Liver of Sulfur—See Potassium Sulfide.
Luna Casutic—See Silver Nitrate.
Magnesia—See Magnesium Oxide.
Magnesia Ponderosa—See Magnesium Oxide.
Magnesium Alba—See Magnesium Carbonate.
Manganese Vitriolata—See Manganese Sulfate.
Massicot—See Lead Oxide.

(Continued on page 462)

Method of Chromic Oxide Determination

Government Chemists Claim That New Method Permits Rapid Handling of Ore Samples Submitted for Analysis—Allows Forty Determinations in Eight Hour Day.

By W. C. RIDDELL and ESTHER KITTREDGE[*]

THE method described below was developed for the rapid determination of chromic oxide in ores and mill production submitted for analysis in connection with the War Minerals Investigation, being conducted by the U. S. Bureau of Mines. No particular originality is claimed for the method. The procedure has, however, been carefully standardized and experimental data has been obtained with respect to several important factors which may affect the accuracy of the method.

The ore should be ground to about 100 mesh. Weigh out 0.5 grams and brush into a 20 cc spun iron crucible in which has previously been placed 4 to 5 grams of sodium peroxide. Mix thoroughly by stirring the charge with a glass rod, cover with a little sodium peroxide and fuse at a red heat. After the charge has melted, it should remain in the molten condition for approximately five minutes. Allow the crucible to partially cool, place in a 400 to 600 cc beaker of pyrex or other low expansion glass, add about 100 cc of water and digest until the fused mass has disintegrated, after which remove and rinse the crucible. Boil for at least five minutes to decompose the sodium peroxide. Without filtering neutralize the solution with ¼ sulfuric acid and add 25 to 30 cc excess. Dilute to 300 to 400 cc with cold water and titrate with a standard solution (about O.2N) of ferrous sulfate. A slight excess of the ferrous sulfate solution is added, as indicated by spot plate tests with a weak solution of potassium ferricyanide (about ½ per cent. solution) and the determination is finished by back titration with standard potassium dichromate solution. The ferrous sulfate solution may be added rapidly without great care, as the approximate end point is quite easily recognized by the color change of the solution. With some practice 3 or 4 spot tests should be sufficient to determine the exact end point.

The quicknes of the method is due largely to the omission of filtration before acidifying the solution, and to the use of a standard $FeSO_4$ solution. One determination requires about two hours and a set of 10 can easily be run simultaneously by one operator. This corresponds to about 40 determinations in an eight-hour day.

Contrary to the statement found generally in the text books extreme fine grinding is not essential. Reduction to 100 mesh is ample for all purposes as is shown by the following analysis of three samples of ore which were submitted to the standard procedure except in the matter of grinding.

	%Cr_2O_3 Found		
	Sample 1,	Sample 2,	Sample 3
Ground to pass 80 mesh	49.6	35.4	53.8
" " " 100 "	49.6	35.4	54.3
" " " 200 "	49.8	35.4	54.1

Decomposition of Sample.

Chromite which is more difficult to decompose than the minerals usually associated with it yields readily to fusion with Na_2O_2. The so-called "technical" grade of Na_2O_2 may be used. A spun iron crucible is usually employed and will last for five or six melts. If care is exercised the failure of the crucible does not necessarily mean losing the charge and in some 200 determinations only two fusions have been lost in this laboratory. When iron as well as chromium is to be determined in the sample a heavy 20 cc porcelain crucible should be used. These crucibles will usually stand three or four fusions. An electric or other type of muffle furnace held at low red heat is preferred for making the fusion. The bottom of the muffle should be protected by a thick sheet of asbestos board or transite. The charged crucibles may be placed at once in the hot muffle without danger of spattering, and covers are unnecessary. When the fusion is made over a burner, the crucible should be covered and considerable care exercised to avoid spattering.

The following experiments were made to determine the time required for the complete decomposition of the chromite by fusion with Na_2O_2. All samples were ground to pass 100 mesh, and except for the time of fusion submitted to the standard procedure.

	%Cr_2O_3 Found		
	Sample 1	Sample 2	Sample 3
Heated until just melted	49.6	35.1	54.0
Fused 2 min. after melt.	49.8	35.4	55.0
" 5 " " "	49.9	35.4	55.1
" 10 " " "	49.8	35.4	55.1

From these results it is evident that it is amply sufficient to hold the charge in a molten condition for five minutes.

Not only during this phase of the new method is it possible to reduce very materially the time necessary for the making of tests, but as will be shown by the account of experiments which follows, a similar reduction can be made throughout.

The following experiments which were identical except as regards time of boiling, indicate that five minutes is sufficient to decompose the H_2O_2 (formed by reaction of Na_2O_2 with H_2O) in solution.

---

[*] *Published by permission Director United States Bureau of Mines.*

	$\%Cr_2O_3$ Found		
	Sample 1	Sample 2	Sample 3
Acid added without boiling	—	48.1	54.0
Heated just to boiling	14.8	49.3	55.1
Boiled for 5 min.	14.9	49.4	55.3
Boiled for 10 min.	15.0	49.3	55.2

If any H_2O_2 is present in the solution when the H_2SO_4 is added, some chromate will be decomposed leading to a low result.

The alkaline solution containing the precipitate inclines to bump on boiling. A few chips of fresh unglazed porcelain or a solid stirring rod with a roughened end placed opposite one of the points where the beaker makes contact with the hot plate, minimized this difficulty.

Non-removal of Precipitate.

The quickness of the method is partly due to avoiding the tedious filtration of the alkaline solution. Except when manganese is present, filtration is unnecessary as is shown by the following parallel determination on a number of samples.

Solution acidified without filtration	Solution filtered before acidifying	In precipitate
38.5	38.6	—
40.4	40.0	0.3
56.4	55.7	—
49.3	49.1	0.2
53.8	55.3	0.3
55.2	55.0	—
55.8	55.6	—
55.7	55.4	0.2

In certain cases the precipitate after considerable washing was dissolved in acid. This solution was then made alkaline, the precipitate removed by filtration, and the chromium determined in the filtrate. These experiments show that it is quite difficult to completely remove the chromate from the bulky gelatinous precipitate. The short procedure which we have adopted is therefore the more accurate unless interfering substances are present.

Interfering Elements.

Determinations were made in which small quantities of cobalt, nickel and copper salts were added to known samples before starting the analysis. These additions did not influence the result.

Manganese is the only interfering element which is at all likely to be found associated with chromite. When this is present it will appear in the form of hydrated di-oxide as a brown gelatinous precipitate after the solution has been acidified. In this case filtration is necessary. Filtration may be considerably facilitated by the addition of mascerated filter paper.

The standard $FeSO_4$ solution should be about 0.2 normal. This solution is prepared by dissolving 56 to 60 grams $FeSO_4 \cdot 7H_2O$ in about 800 cc distilled water to which has been added 100 cc concentrated H_2SO_4. The heat generated by the addition of the H_2SO_4 readily effects the solution of the ferrous sulfate. After cooling the solution is diluted to one liter. The 0.2 normal K_2Cr_2O7 solution may be made by dissolving 9.806 grams C.P. K_2Cr_2O7 in one liter. The $FeSO_4$ solution may be standardized with a standard $KMnO_4$ solution based on Bureau of Standards sodium oxalate, or against the K_2Cr_2O7 solution, provide this was made from a salt of known purity. The $FeSO_4$ solution acidified as suggested is quite stable and if properly protected requires checking against the standard K_2Cr_2O7 solution only two or three times a week.

One cubic centimeter of 0.1 normal solution is equivalent to 0.001733 grams Cr, or 0.002532 grams Cr_2O_3.

CROSS INDEX OF TERMS

(Continued from page 460)

Marble—See Calcium Carbonate.
Melaconite—See Cupric Oxide.
Metallum Album—See Arsenious Oxide.
Milk of Barium—See Barium Hydroxide.
Mineral Butter—See Antimony Chloride.
Mordant Salts—See Potassium Antimony Tartrate.
Muriate of Aluminum—See Aluminum Chloride.
Muriate of Antimony—See Antimony Chloride.
Muriate of Arsenic—See Arsenic Chloride.
Muriate of Cadmium—See Cadmium Chloride.
Muriate of Calcium—See Calcium Chloride.
Muriate of Cobalt—See Cobalt Chloride.
Muriate of Copper—See Copper Chloride.
Muriate of Iron—See Iron Chloride.
Muriate of Lead—See Lead Chloride.
Muriate of Lime—See Calcium Chloride.
Muriate of Manganese—See Manganese Chloride.
Muriate of Mercury—See Mercuric Chloride.
Muriate of Silver—See Silver Chloride.
Muriate of Soda—See Sodium Chloride.
Muriate of Zinc—See Zinc Chloride.
Natron—See Sodium Carbonate.
Natron Vitrolate—See Sodium Sulfate.
Natrun—See Sodium Carbonate.
Neutral Sulfate of Alum—See Aluminum Sulfate.
Nickel Black—See Nickel Oxide.
Nigri Precipitatus—See Ammonium Mercurous Chloride.
Nil Alba—See Zinc Oxide.
Nil Album—See Zinc Oxide.
Nitre—See Potassium Nitrate.

(To be concluded.)

A charter has been granted to the Sanitary Flooring Co., Inc., Manhattan. The authorized capital of the company is $25,000. The incorporators are J. B. Cheney, 51 West 21st Street, New York City; C. H. Pardoe, Washington, D. C., and L. R. Lord, 609 West 137th Street, New York City.

To manufacture drugs, chemicals and medicines, the Partola Distributing Company has been incorporated under the laws of the State of New York with an authorized capital of $95,000. S. A. Clarkson, 1566 East 13th Street; F. F. Carroll, 256 Warren Street, and A. M. Hicks, 543 Ninth Street, Brooklyn, are the incorporators

Potash Situation Growing Serious

United States Still Unable to Provide Her Own Full Requirements—Output Today Approximately Twenty Per Cent. of the Country's Normal Needs.

By R. C. RANDALL

THE announcement from San Francisco early this month that another unit of the American Trona Company's plant at Searles Lake in Southern California, has started operation, served to mark another stage in the systematic efforts both Government and private agencies have been putting forth, since the outbreak of war with Germany, to make the United States independent of foreign potash sources.

The announcement is important because it serves to indicate that today most development work so far as potash is concerned is being done where it seems most likely to result in the establishment of a permanent industry—that is in the Searles Lake district.

It is also important because it offers ground for hope that in the not far distant future the American fertilizer manufacturer and the American farmer and all other industries which depend for one or other of their materials upon the potash supply will be again assured of an adequate supply at a reasonable price.

During 1913 there was imported, principally from Germany, 228,552 tons of K_2O. At the beginning of 1917 the Committee on Fertilizers of the Chemical Industry of the Chemical Alliance estimated that the country's needs in the direction of potash during the year ahead would be 218,899 tons. A summary of the estimates made by the directors of the various state agricultural stations by the Department of Mines showed that the minimum requirements during the present year would be in the neighborhood of 150,000 tons, based upon the present percentage of potash now used in fertilizers. As the present potash content of most fertilizers is universally acknowledged to be too low—the inevitable result of war conditions—and the total output during 1917 was only twenty per cent. of the minimum requirements for 1918, the situation is today serious.

Demand to Increase.

The future will see, if anything, an increased demand for potash in the United States. Conservative estimates place the demand during 1919 at 250,000 tons. According to reports by the Department of Agriculture at Washington the soil in many parts of the country, due principally to the unusual demands that have been placed on the farmers in the direction of increased production and second to the low potash content of the war time fertilizers, are giving marked evidence of "potash hunger." Experiments conducted in Maine by officials of the erate quantities of potash to the evil, doubled the output of potatoes and that the potash could not be replaced by any other ingredients. The experiments conducted here further proved that the amount of potash required by the soil conformed more or less closely to pre-war practice and proved to the satisfaction of the experimenters, that so far as truck crops, at least, were concerned, any reduction of the potash content of the fertilizers used could not help but prove injurious to the crops.

Much similar conclusions have been reached in regard to the cotton crops of the South. There is Department showed that the addition of even mod- a tendency at present among agriculturists to blame the prevalence of "rust" upon the fact that in almost every case "rust" appears only on soil deficient in potash. According to estimates made by officials of the Department of Agriculture a normal cotton crop contains about 270,000 tons of potash. The quantity of potash required for such a crop on a basis of two per cent K_2O, would require 100,000 tons of K_2O.

Soil Being Impoverished.

Ever since the flow of potash from German sources stopped with the outbreak of war in Europe, the soil of the United States has apparently been subjected to a progressive impoverishment. Strenuous efforts have been made to replace the supply which war conditions removed, by potash obtained from domestic sources but as the figures given above show, so far without entire success. From now on with the feeding of the greater part of Europe dependent upon the efforts of American farmers and the productivity of American farms, the question of an adequate potash supply becomes not only of national but of international importance.

Whether or not we can expect a return to prewar conditions so far as the importation of potash from Germany is concerned, it is of course at this early stage of the peace negotiations impossible to say. But it can be said with a fair degree of safety that even if the final peace arrangements permit of any approximation of the freedom of commercial intercourses with the ci devant Teutonic Empire which prevailed before the war, it is of course questionable whether the German supply of potash can be depended upon for some time to come, due principally to the disturbed condition of the country and the inadequacy of the available merchant marine of all countries.

It is therefore as imperative as ever that no effort be spared on the part of the Government or private enterprise to develop all possible sources of potash in the United States, because it will be upon these sources that the country will apparently have to depend for some time to come.

It is on account of this condition of things that an inventory of America's available potash resources is interesting and important.

Some appreciation of the situation in the United States can be obtained from the following table giving in detail the amount of potash obtained during 1917 from various sources:

	Tons K_2O.	Per cent. of total production
Mineral sources:		
Natural brines	20,652	63.4
Alunite	2,402	7.3
Dust from cement mills	1.621	5.0
Dust from blast furnaces	185	0.6
Organic sources:		
Kelp	3,572	10.9
Molasses residue from distillers	2,846	8.8
Wood ashes	621	1.9
Waste liquors from beet sugar refineries	369	1.1
Miscellaneous industrial wastes	305	1.0
Total	32,573	100.0

Today most of the potash produced in the United States comes from the Nebraska lakes and Searles lakes of southern California.

The Nebraska lakes are a series of small shallow lakes in the sand hill region of Nebraska, north and south of the Chicago, Burlington & Quincy Railroad, between Alliance and Lakeside. Something like seventy-five per cent. of these lakes contain sufficient potash to make the extraction commercially interesting. They contain brine of varying strength and have a bottom of muck and hardpan, beneath which is found a bed of sand from two to forty feet thick. This sand is in most cases soaked with brine of a composition similar to that in the lake above. At first the production of potash depended upon the water in the lake only but today the sands beneath are the principal source.

Worked from Wells.

Today these lakes are being worked by means of wells sunk in the lake beds. By means of a suction line the brines taken from these wells are pumped to reduction plants, where they are partly evaporated by solar towers and later in driers or in some cases in large open tanks heated by means of steam coils. Later the salts are dried in rotating furnaces, heated by the direct flame of oil burners. Before shipment the salts are dried, ground and packed in bags.

There are at present four plants turning out potash in this district, the four having a capacity of about 100,000 tons of potash salts per annum. This probably represents about 25,000 tons of K_2O.

Most of the salts being turned out in this district are being used in fertilizers. While the Nebraska salts have the advantage of a low content of chlorides, objection is made to them in some quarters on account of their alklinity. This the chemists of some of the fertilizer companies claim prevents their use in anything but the low grade fertilizers at present being used.

According to competent opinion * the Nebraska lakes cannot be considered as a permanent source of supply. When the plants now operating and those under construction and contemplated are run at full capacity, it would seem that the supply of high grade brines will be reduced within a few years.

The cost of production at this point permits of potash salts on a basis of 28 per cent. K_2O, being laid down on the Atlantic seaboard at about $1.50 per unit of K_2O. The cost of production is said to be about $30 a ton.

While the Nebraska Lake district will be an important source of supply, so long as the present demand for potash continues it cannot be looked upon in the same way as the Searles Lake.

Searles Lake is a salt incrusted valley floor with an area of twelve square miles. The depth of the salt beds is from sixty to one hundred feet, averaging about seventy-five feet in the main part of the deposit. The deposit is really a mass of salts crystalized from an evaporated mother liquor brine, in which the salts are still immersed. First estimates of the contents of this deposit gave 4,000,000 tons of K_2O. But this is today considered too conservative. It seems likely that 12,000,000 tons would be nearer the correct figure.

At Searles Lake plants are being operated by the American Trona Company and the Pacific Coast Borax-Solvay Process Company. The American Trona Company, the largest producers of potash in the United States, has a concentrating plant at Trona capable of handling 4,000,000 gallons of brine a day. The brine is evaporated at the plant and concentrate shipped to a refinery at San Pedro, California. The estimated output for 1918 is 15,000 tons. This output will likely be doubled in 1919 and it is expected that eventually the total output will be close to 100,000 tons.

The Future of Searles Lake.

According to a statement made in a recent review of the situation at Searles Lake by an official of the Department of Mines, the cost of production at this plant cannot yet be definitely determined. It is likely that the cost will depend upon the quality of the output. In this review it is pointed out that the future production of this plant depends to a great extent upon the ability of the market to absorb the by-products of salt, borax and soda. This the market cannot do, it is claimed, if the plant is worked to capacity.

Next to the brines, derived from these two sources, the United States is obtaining most of its potash from alunite. The only deposits of this mineral being worked on a commercial scale are located at Maryvale, Utah. The plant of the Minerals Products Corporation at this point turns out about 20 tons a day of 97 per cent. potassium sulphate.

The process used at this mill involves the crushing of the alunite to the size of about one inch. After going through the crushers the alunite is roasted in rotary kilns, 7 feet 6 inches by 135 feet, pulverized coal being used as fuel. After calcining the material is leached with hot water in a closed tank at a temperature equivalent to a steam pressure of 60 pounds, the potassium sulphate going into solution. The solution is then sent through a filter press; the clear filtrate is evaporated in triple effect evaporators and the residue sacked.

At present no use is being made of the alumina left after the potash has been leached. No estimate of the cost of production is available but it is understood that the minimum freight rate on a high grade potassium sulphate to eastern points would probably amount to 25 cents a unit of K_2O, so that unless the alumina can be utilized in some way the opinion has been expressed that this plant cannot operate at a profit under normal peace time conditions.

A considerable quantity of calcined alunite is at present being marketed among fertilizer manufacturers as experiment has shown that this is as effective per unit of K_2O as the soluble sulphate and chloride salts. Calcined alunite will not likely due to its low content of K_2O be much in favor for this purpose when normal industrial conditions return again, because of the high freight rates involved in its transportation.

A great deal has been heard lately of the potash recovered from kiln dust produced at cement plants. While of course the supply of potash available from this source is somewhat limited the estimated cost at which it is produced, thirty to fifty cents a unit of K_2O will enable the mills to compete with the German product on the basis of pre-war products.

Discovered by Accident.

Two American cement plants have been conspicuously successful with this method of producing potash. The first, the Riverside Portland Cement Company, of California, can be credited with having discovered this method of producing potash. Threatened with numerous suits from fruit growers in the vicinity of their plant, on the ground that the dust from their mills were ruining the fruit trees, they installed an electrical dust precipitating plant to abate the dust nuisance. The dust collected by this plant when analyzed was found to contain a ten per cent. potash content. This plant has been operated ever since 1913 and has proved highly profitable.

Similar plants are being operated with equal success by other cement plants in various parts of the country. All seem to have found that not only does the production of potash involve no change in the ordinary methods of manufacturing cement but that in some cases the installation of such a dust precipitating plant leads to a reduction of as much as ten per cent. in the consumption fuel. This is due to the more careful attention required in the burning of the cement.

An investigation recently completed by the Bureau of Soils indicated that the probable maximum amount of potash that might be recovered from all the cement works in the country would be 100,000 tons of K_2O per year. It is not likely that dust collecting plants will ever be installed at all cement works, but it seems reasonable to expect that the amount of K_2O to be derived from this source should reach 50,000 tons a year, or 20 per cent. of the total normal requirements. Probably this amount could be increased somewhat by using where available rock containing more K_2O in the raw mix.

An objection raised to cement-kiln dust as a source of potash in manufacturing fertilizers is that if used in large quantities the lime content will cause reversion of the soluble phosphoric acid in the phosphate and loss of the ammonia in ammonium sulphate. The K_2O content of cement-kiln dust is also too low to permit its use as the only source of potash in a fertilizer that is to contain more than 3 per cent. of K_2O. However, these objections can easily be overcome, and some potassium sulphate containing 40 per cent. of K_2O is now being marketed by one of the cement works.

Space forbids a detailed description of the various methods of obtaining potash, which under the stimulus of the war, have been developed in the United States, but in addition to the brine lakes, alunite mines, and cement works, mention must be made of three other less well known sources, the dust from blast furnaces, the feldspars and other silicates and kelp.

The recovery of potash as a by-product of the manufacture of pig iron was first investigated at the plant of the Bethlehem Steel Company. Dust collected in the stove and furnace passes was found to contain ten percent of potash. Further investigation revealed the fact that this potash represented only a small proportion of the potash produced as over 67 percent escaped up the stacks and in the primary washers.

Two Plants Building.

A plant is now being erected at Bethlehem to collect potash from these gases and another will likely be built in Alabama. No figures regarding the total potash produced in blast furnaces are yet available.

The development of this source is regarded as very promising by those who have made a close study of the potash situation and the opinion is expressed among some engineers that with proper encouragement from the Government the combined efforts of the iron and cement industries should be able to provide the country with sufficient potash for all its needs.

The extraction of potash from feldspars and other silicates is still more or less in an experimental stage but this method of obtaining potash is believed to promise good results in the not far distant future. Deposits of greensand containing payable quantities of K_2O exist in many localities within easy reach of the centres where fertilizers are most in demand.

The kelp which grows in immense quantities off the Pacific coast has been regarded for many years as an admirable fertilizer, but it was not until the outbreak of the war and the incidental demand for potash that extensive efforts were made to make available the potash content of this sea weed.

It has been estimated that from Cape Flattery to San Diego there is sufficient kelp to furnish 250,000 to 400,000 tons of K_2O annually. This estimate is believed to overstep the mark somewhat as all of the kelp which grows on the coast, on account of the exposed position of parts of the coast line, cannot be harvested.

Several plants are now in operation on the Pacific coast and the output from this source ranked second during 1917.

The kelp is harvested by machine cutters, loaded on barges and brought to shore, and either dried and ground or reduced to a char. This product may be used either as a fertilizer or as a basis material for the production of high grade potassium chloride.

The plant of the Hercules Powder Company at this point is now producing potassium chloride 97 to 98 percent pure in substantial quantities and also acetone, iodine and ethyl products.

Summing up the future possibilities of this district in a report prepared for the Department of Mines, A. W. Stockett expresses the opinion that the permanence of the kelp potash industry depends upon the possibility of obtaining a market for the byproducts. He believes that the location of the beds and the fact that only one percent of the potash used in the United States goes West of the Rockies, limits the ability of this source to supply the needs of the Eastern States.

The same writer in summing up the whole potash situation as it exists in the United States says: "to sum up the normal requirements of the country are 250,000 tons of K_2O a year. The total production during 1917 was 32,573 tons of K_2O: the present principal sources are natural brines, kelp, molasses residue, alunite and dust from cement kilns: the most promising sources of a permanent supply sufficient for all future requirements are the natural brines from Searles Lake, dust from the cement kilns and blast furnaces, with favorable prospects from the green sand deposits."

Dr. Pickrell Favors Census

Census of Chemical Imports Most Important, He Claims.

ADVANTAGES to be derived by American chemical industries from the census of chemical imports and the methods of its preparation were discussed in a paper recently presented before the New York Section of the American Chemical Society by E. R. Pickrell. After crediting the idea of the census to Dr. Bernhard C. Hesse, Mr. Pickrell said in part:

"The census of chemical imports is a much greater and more difficult task than the dyestuff census, for it entails the procurement of information relating to a vast and varied number of articles. The statistical data presented by this census will not only be of value to chemical manufacturers but to the drug manufacturers, synthetic medicinal manufacturers, perfumery manufacturers, paint and varnish industries, oil industries and fertilizer industries.

"During the fiscal year 1913-1914, chemicals, allied chemicals, drugs and medicinals imported into this country totaled in value $176,000,000. This total was divided as follows:

Chemicals, drugs, dyes and medicines	$95,000,000
Oils	46,000,000
Fertilizers	23,000,000
Tanning materials	2,000,000
Perfumes	2,000,000
Paints	2,000,000
Glue	2,000,000
Grease and oils	1,000,000
Soap	1,000,000
Oleostearine, dyewoods, beeswax and blood (each)	500,000

"Inasmuch as the object of the Census of Chemical Imports was to show the quantity, value, country of origin, and per cent. of the quantity imported from each foreign country of every chemical, drug, allied chemical and medicinal imported into this country for the fiscal year 1913-1914, the last normal year, and since there was no available statistical data in this country setting forth this information, it was necessary to examine every invoice filed at the different custom houses in this country during that one fiscal year.

"In view of the fact that more than sixty per cent. of all the articles imported into the United States come through the port of New York and that probably seventy-five per cent. of all the chemicals imported are entered here, it was deemed advisable that the clerical staff engaged on the census personally examine the New York entries.

"The original request was made to the Secretary of the Treasury that all invoices, some 700,000 received in the United States for the fiscal year 1913-1914, be forwarded to the Port of New York for examination by the staff engaged in the census.

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By CARLETON ELLIS and A. A. WELLS*

Part XIX

In addition to the narrow group of bands between $\lambda = 270$ and 230 $\mu\mu$, according to *Stark* and *Levey* (Jahrb. Radiaokitv. Elektronik. 1913, 10, 179; J. Chem. Soc. 1913, Abs. *104*, ii, 366) the absorption spectrum of benzene shows a much more intense group of similar bands in the region $\lambda = 210$ to $\lambda = 190$ $\mu\mu$. Naphthalene behaves in the same way, a group of narrow intense bands being found in the region $\lambda = 220$ to $\lambda = 190$ $\mu\mu$ in addition to the less intense group situated between $\lambda = 310$ and $\lambda = 230$ $\mu\mu$. Both the naphthalene bands are displaced towards the direction of greater wave-lengths relatively to the corresponding benzene bands. The absorption spectra of cyclohexene and Δ 1:3—cyclohexadiene, on the other hand, exhibit unresolved broad bands differing completely from the groups of narrow bands shown by benzene and napthalene. From the totally different character of the benzene bands as compared with those of cyclohexene and ∇ 1:3—cyclohexadiene, the conclusion is drawn that the benzene ring contains no normal ethylene linkings. Reference is made to the fact that the observed molecular refractivity of benzene agrees with that calculated on the assumption that benzene contains three normal linkings. This agreement does not, however justify the conclusion that three such linkings are present. According to Stark and Levey, the ultra violet absorption of benzene would seem to show that agreement is accidental and due to the circumstances that the refractivities of the actual linkings are mutually affected by their close approximation (as in the case of conjugated ethylene linkings), and that the modified refractivity is practically equal to the refractivity of a normal ethylene linking.

Former investigators having made reference to the irregular band spectrum of p-xylene in the ultra violet, *Mies* (Zeitsch. wiss. Photograph. Photophysik. Photochem., 1909, 7, 357) investigated the absorption in the ultra violet of p-xylene vapor and also of solutions of p-xylene in alcohol. In no case is there an alteration in the selective absorption. Neither temperature, nor thickness of the absorbing layer nor pressure have an influence on the heads of the bands. There is not any evidence of the broadening of the bands. With a constant thickness of the absorbing layer, rise in temperature appears to increase the intensity of the heads of the bands of the longest waves. The general absorption increased with the temperature and with the thickness of the absorbing layer. It is most marked toward the red end of the spectrum, and gradually increases in the direction of the shorter wave-length, until at $\lambda = 2389$ it becomes zero. The spectrum is a very pronounced band spectrum, in which the individual bands are not resolved. All the bands have their edges toward the violet, and become diffused towards the red.

In order to ascertain the influence of the relative position of the methyl groups on the ultra violet absorption spectrum *Mies* (Zeitsch. wiss. Photochem., 1910, 8, 287; J. Chem. Soc., 1910, Abs., *98*, ll, 563) has investigated the vapors of o- and m-xylene by the same method as that previously used for p-xylene. The absorption of m-xylene is considerably weaker than that of the p-compound, and contains only one series of bands instead of the two exhibited by p-xylene. The absorption of o-xylene is still smaller. The relative behavior of the three xylenes in the liquid state is similar to that found by the examination of the vapors.

Ethyl Benzene.

The absorption spectrum of ethyl benzene in the ultra violet has been examined by *Weimer* (Zeitsch. wiss. Photochem., 1913, *12*, 33) over the interval $\lambda = 2300$ to $\lambda = 2750$, observations being made on the vapor at temperatures between 20° and 80°, and on ethyl alcohol solutions containing from 0.02 to 50% of ethyl benzene. In both cases, the spectrum consists of a series of bands which are shaded off towards the red end of the spectrum. With rise of temperature the vapor bands broaden out towards the red end, but the short-waved edges of the band are unaltered in position by either change of temperature or of the thickness of the vapor column. In the case of the solution spectrum, on the other hand, it is found that the bands are displaced towards the red as the concentration is increased. On comparing the ethyl benzene spectrum with that of toluene, it is seen that the two are identical except for the fact that the former is displaced towards the ultra violet to the extent of 0.7 $\mu\mu$.

MISCELLANEOUS HYDROCARBONS.

A large number of hydrocarbons have been examined by *Stark, Steubing, Enklaar* and *Lipp* (Jahrb. Radioaktiv. Elektronik., 1913, 10, 139; J. Chem. Soc., 1913, Abs., *104*, ii, 363) with reference to their behaviour towards ultra violet rays of short wave-length. By means of a fluorspar spectrograph, it has been possible to obtain satisfactory photographic records of the absorption spectrum as far as $\lambda = 185$ $\mu\mu$, and in this way the region covered by previous investigators has been considerably extended. The hydrocarbons were examined in the form of vapor, the rays being caused to pass through a layer of constant thickness, while the pressure was reduced in a series of steps in order to obtain the spectrum for different concentrations. The experimental observations are interpreted in accordance with the view that the absorption of ultra violet light is a specific property of the carbon atom. The seat of the absorption is supposed to be the valency electron, and the position of the obsorption band is further supposed to depend on the linking with which the valency electron in question is associated.

---

* All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

The experimental data indicate that the linkings C—H and C—C do not give rise to an absorption band at wave-lengths greater than λ 185 $\mu\mu$; bands are found in this region, however, in the case of the linkings C=C and C≡C. Hydrocarbons which contain asymmetric double linkings or triple linkings give rise to two broad bands and it may, therefore, be supposed that the four or six valencies associated with the C=C and C≡C linkings respectively are approximately equivalent as regards their ultra violet absorption, and the bands may, therefore, be regarded as peculiar to the linkings as a whole. The presence of two or more C=C or C≡C linkings in the molecule of a substance has an appreciable influence on the position as well as the intensity of the absorption, and the nature of these effects is indicated by the curve for different classes of hydrocarbons. The data for hexane, cyclohexane, camphane indicate that the C—C linking, whether in an acyclic or a cyclic compound, does not give rise to selective absorption above λ 185 $\mu\mu$. Although the absorptions do not show a fully developed band, it would appear that ring formation causes a shift towards the long-waved region. These results show that the carbon valency associated with an asymmetric C=C linking, whether in a cyclic or an acylic compound, gives rise to two broad bands in the ultra violet region above λ 180 $\mu\mu$. As compared with the position of the bands due to a single C=C linking, it appears that the bands are displaced towards greater wave-lengths, and at the same time intensified, if the C=C linking is endo- or semi-cyclic, or if the linking is conjugated with reference to a second C=C linking.

Other compounds examined were isobutylene, methyl butylene, hexylene, octylene, diallyl, geraniolene, methyl butadiene, dimethyl butadiene, methyl pentadiene, hexadiene, camphene, bornylene, pinene, limonene sylvesterene, phellandrene dimethyl fulvene and ethylene. Liquid ethylene was found to absorb ultra violet rays up to λ 235 $\mu\mu$.

Pauer (Chem. Centr., 1896, i, 1122; Ber. Physikal. Med. Soc. Erlangen, *27*, 120; J. Chem. Soc. 1897, Abs. *72*, ii, 393) examined benzene, toluene, the xylenes, ethylbenzene, chloro-, bromo-, iodo-, nitro-, amido-, azo-, and amidoazo-benzene; carbon bisulphide pyridine, thiophene, anthracene, and naphthalene to determine their absorption spectro in the ultra violet. All the compounds in the liquid state or in solutions of suitable concentration give rise to absorption bands near the cadmium lines 17—20. The absorption spectra of the same substance in solution in different solvents show a displacement towards the red which increases with the refractive index or the dispersion of the solvent. The absorption spectra of the vapours consist of lines, or groups of line, which form one or more bands as the substance passes from the gaseous to the liquid state. The position of the bands for the liquid is always nearer the red than that of the lines or groups of lines, for the vapour.

The influence of constitution on the absorption in the case of the benzene derivatives was not found to follow any regular course. The character of the absorption alters entirely with the substitution of different hydrogen atoms. Nitro-benzene and iodo-benzene in the gaseous state, he states, give rise to no lines whatever. Benzene, naphthalene, and anthracene in solution each give four bands, which lie nearer to the red the greater the molecular weight of the compound. The substitution of N and CH entirely alters the character of the benzene spectrum. The absorption in the case of benzene is very intense, so that even traces of the vapour of the former in admixture with air could not be detected.

The ultra violet absorption spectrum of the vapors of a number of mono-substituted derivatives of benzene has been examined by *Strasser* (Zeitsch. wiss. Photochem., 1915, 14, 281; J. Chem. Soc., 1915, Abs., *108*, ii, 499). The wave-length data for the absorption bands exhibited by benzaldehyde, benzonitrile, benzyl alcohol, benzyl ethyl ether, and benzoic acid show that the spectra of these derivatives are similarly constituted.

Purvis (Proc. Camb. Phil. Soc. 1909, 15, 89) has also compared the absorption spectra of mesitylene and trichloromesitylene in 0.001 molar ethyl-alcholic solution. By the introduction of the three chlorine atoms the strong absorption band is shifted towards the red from λ 269 — λ 254 to λ 287 — λ 263 $\mu\mu$. The persistence of the latter is very much greater than that of the mesitylene band.

The influence of substitution in the benzene nucleus on the nature of the light absorption has been further examined by *Purvis* (J. Chem. Soc. Trans. 1015, 106, 660) by comparative observations on the absorption of anisole, p—bromoanisole, phenetole, p—flourophenetole, p—bromophenetole, o— and p— anisidines, o— and p—phenetidines, p—azoxyanisole and p—azoxyphenetole. The results obtained with anisole and phenetole show that the introduction of an aliphatic group does not alter the character of the absorption, although the bands are not so sharp as those of phenol. When fluorine or bromine is introduced in the nucleus

(Continued on page 473)

COAL-TAR CHEMISTRY SECTION

THE CHEMICAL ENGINEER

Devoted to the Interests of All Producers and Consumers of Coal-Tar Derivatives

Crudes, Intermediates. Artificial and Natural Colors. Synthetic Medicinals, Flavors and Perfumes. Explosives, Photographic Developers.

Should Nationalize Color Trade

President National Aniline and Chemical Company Claims U. S. Should Take Step.

AT the recent manufacturing conference of the the National Aniline & Chemical Company, Inc., held at Buffalo, Mr. William J. Matheson, president of the company, speaking of the future of the color business, emphasized the immediate necessity of nationalizing the color industry in the United States as was done in other important civilized countries.

"Germany nationalized the color industry there long before the war; France has now nationalized it; Japan has nationalized it; Great Britain has nationalized it; and it is absolutely essential that the United States should do so.

"We must divorce our minds from the situation that prevailed before the war. The very fact that Germany united all works under one system for their own protection leaves this country no alternative. France has met this situation; Great Britain has met it; Japan has met it; and this country must meet it."

Mr. Matheson said that there was no doubt but that Germany had sold some goods below the cost of manufacture, when a discontinuance of manufacture would tend to disorganize the whole plant of Germany; or where it would operate to put American companies out of business. The German manufacturers operated together and distributed the loss over all. They stated quite frankly that they did not think it advisable to allow this industry to become profitable in the United States. The price was never predicated on what the product cost, but on how much it would bear. He emphasized the fact that years before the war, when six big companies were operating in two groups, the German dye manufacturers were "competing under control."

Over $3,000 has been contributed to the Ramsay Memorial Fund in the United States up to November 1. It is hoped that the American subscription may reach $10,000 by January 1, 1919. Checks should be made payable and sent to the Ramsay Memorial Fund Committee. W. J. Matheson, Treasurer, No. 2 Burling Slip. New York City.

Temperature Factor in Silk Dyeing

Dynamite Bath Should Not Be Over Sixty Degrees.

The preservation of silk during its passage through the dye-house is of vital importance. Few dyers thoroughly understand the necessity of guarding it against every possible attack by either mechanical or chemical influences, according to the American Silk Journal.

One of the most essential points is the temperature of the dynamite bath, which should on no account be permitted to rise above 60 degrees Fahrenheit. Silk immersed in a dynamite bath having a higher temperature than 60 degrees Fahrenheit, becomes tender, and when once attacked, there is no possible chance of restoring its strength. To keep the dynamite bath properly cooled, the use of ice water is necessary.

A double-walled lead-lined tank, to permit cold water to circulate, is excellent, or a cooling coil of lead pipe around the inside of the tank is better. Generally, stone crocks, one at each end of the tank, will suffice. They should be large enough to contain about 75 to 100 pounds of ice when broken into fragments.

Before putting the silk into the tin, the thermometer should be used, and if the temperature of the liquor is much above 60 degrees Fahrenheit, the use of a fair-sized chunk of ice directly in the tin will soon lower the temperature, without materially altering the density of the bath. As soon as the proper temperature is obtained, the ice is removed from the liquor and put in one of the crocks. It is a good silk insurance to keep a thermometer near the tin liquor and to insist upon its use, especially in summer time.

R. N. Ball, Jr., has been appointed assistant manager of the New York Oil Department of Marden, Orth & Hastings Corporation. Mr. Ball was formerly associated with this same department before his transfer to the Chicago office of the same corporation.

H. L. Wraight, 1016 Woolworth Building, has been appointed New York representative of the American Nitrogen Products Co., a Washington corporation.

A chemical for preserving art objects has been devised by Dr. Chikashige, of the Kyoto University, according to the Japan Times. The chemical is said to have proved very effective as a preservative of pictures

United States to Be Independent

Chairman of War Industries Board Says War Will Free Chemical Industries

Bernard M. Baruch, chairman of the War Industries Board, believes that shortly America will be independent of the rest of the world, in so far as the chemical and mineral products hitherto obtained from Germany are concerned. The chemical division of the War Industries Board, according to Mr. Baruch under the capable guidance of Charles H. L. McDowell, has met with considerable success in the development of new processes of manufacture and in the manufacture of materials hitherto protected by German patents. So far they have succeeded in inducing American manufacturers to make soluble potash, aniline dyes, optical glass and clay for graphite chemicals of German origin.

In spite of the fact that the food administration recently recommended the use of saccharin as a substitute for cane sugar, the Secretary of Agriculture declares that he will regard any food product in which saccharin has been substituted for cane sugar, as adulterated, under the terms of the Food and Drug Act. Saccharin, according to the Department, impairs digestion when used in quantities over three-tenths of a gram a day and deduces the food value of the substance in which it is used.

Secretary of Commerce William C. Redfield in the course of a plea for the continuance of good will advertising on the part of American exporters, cites the exhibitors at the recent Fourth Exposition of Chemical Industries, in support of his belief that good will advertising should continue in spite of the war and in spite of the fact that few if any manufacturers are in a position to supply goods for export.

"Let me suggest good will advertising for all firms that have no reason to expect improvements in their foreign business while hostilities continue," says the Secretary. "Such advertising does not aim at immediate results. It is intended to keep the name of the firm or of a product before a community when conditions have interfered with actual trading.

"I think the most noteworthy feature of the recent Chemical Exposition in New York was the fact that of all the exhibitors only a very small percentage were looking for orders or could possibly fill orders if they found them. They are devoting all their manufacturing efforts to war purposes, but are giving a reasonable amount of attention to keeping their goods and their marks before their prospective future customers. That is one sort of good will advertising."

A new explosive known as nitrobyronel, the invention of Dr. Byron E. Eldred, is being tested by the Government. It is claimed that this new material blows a chamber twice the size of that blown by trinitrotoluol. As neither nitroglycerin or toluol is used in the manufacture of nitrobyronel, it is believed that a big saving of glycerin can be affected by the use of the new explosive as a substitute.

Secretary of Agriculture Houston has appointed an advisory board to devise methods of drying fruits and vegetables, consisting of representatives of each of the bureaus within the Department of Agriculture. The board will have charge of the growing dehydrating industry of the country.

Dr. Arthur L. Day has resigned as director of the Geophysical Laboratory, Carnegie Institution of Washington, to do research work for the Corning Glass Works, Corning, N. Y.

Chemical Personalities

Lloyd Atkinson Leaves Air Reduction Company—George Chahoon in Baltimore

Lloyd H. Atkinson has resigned as vice-president of the Air Reduction Company, Incorporated, 120 Broadway, New York City. Mr. Atkinson has been in poor health for some time, as result of overwork, and will take an extended vacation before engaging in one of the war service activities.

Mr. George Chahoon, president of the Laurentide Company, is now located in Baltimore, where he is attached to the welfare branch of the Chemical Warfare Service. Mr. Chahoon's services have been loaned by the company to the Government for the duration of the war.

Mr. Lucius Allen, of Bellville, Ont., Canada, has been appointed consulting chemist to the Nitrate Division of the Ordnance Department with the rank of captain.

Dr. Donald Kohr was recently appointed assistant general manager of the Lowe Bros. Co., Dayton, Ohio.

Mr. H. E. Shriver, until recently assistant chemist at the South Carolina Experiment Station, Clemson College, S. C., has been appointed to the chemical engineering staff of the Air Nitrates Corporation at Muscle Shoals, Ala.

Mr. O. L. Thomas, who has been connected for some time past with the experimental station of th E. I. Dupont de Nemours & Co., at Wilmington, Delaware, is now located at the Government powder plant at Jacksonville, Tenn., as chief supervisor of caustic soda manufacture and soda ash recovery.

Mr. William H. Hampton has been placed in charge of the development of miscellaneous gas defense apparatus under Major Waldemar Kops, Gas Defense Division, Chemical Warfare Service, Long Island City.

Mr. Frank P. Fahy, New York City, a magnetic engineer, has been awarded the John Scott Legacy Medal and premium for the development of the Fahy permeameter by the city of Philadelphia.

Mr. J. W. Coy until recently with the Canada Glue Company, Brantford, Ontario, is now connected with the American Glue Co., at Allegheny, Pa.

Dr. Harold S. Davis has been appointed to the research staff of the H. Koppers Co., of Pittsburgh, Pa., one of the largest manufacturers and operators of byproduct coke ovens, benzol and toluol plants. Dr. Davis will carry on his work at the Mellon Institute.

Miss Edith D. Borg, a sister of Myron I. Borg and Sidney C. Borg, bankers, and Dr. Alcan Hirsch, of 360 Riverside Drive, were married October 16 at the home of the bride's sister, Mrs. Alfred N. Goldsmith, 43 Fifth Avenue, the Rev. Dr. Stephen S. Wise officiating. Dr. Hirsch is one of the prominent chemical engineers of this country, and during the war he has been working largely in dyes and drugs for the United States and the French Governments.

To enable him to undertake research work connected with the use of the arc process in nitrogen fixation, Dr. H. K. Bsnson, Director of the Bureau of Industrial Research, University of Washington, has been given a captaincy in the nitrate division of the Army Ordnance Department. Until his entrance into the service Dr. Benson acted as chief consulting chemist to the American Nitrogen Products Co., of Seattle.

DU PONT AMERICAN INDUSTRIES

DU PONT DYESTUFFS

Our Development

When this company made its decision to enter the Coal Tar Dyestuff Industry there were two courses of development open.

First, to manufacture an extensive line of colors by taking advantage of the intermediates that could be purchased on the market. Second, the manufacture at the outset of a more limited number of colors, but starting at the bottom with the crudes and manufacturing in our own plants the intermediates required.

The adoption of the first policy would have enabled us to put on the market at an early date a large line of colors which would have found ready sale at considerable profit to ourselves. The second course meant necessarily that our development would be less rapid, that the variety of colors produced at first should be less great and that return upon the increased capital it would be necessary to invest could not be expected for a considerable length of time.

We chose the latter of these two courses because we believe that the only safe foundation for the development of a self-contained American color industry is the manufacture of a comprehensive line of intermediates, starting at the bottom from the crudes and on such a large scale as to make it economically sound.

Our course is of the most vital interest to the various dyestuff consuming industries, for it guarantees to them an adequate supply of dyestuffs that can never be cut off to leave them again dependent on foreign supplies.

E. I. du Pont de Nemours & Co.

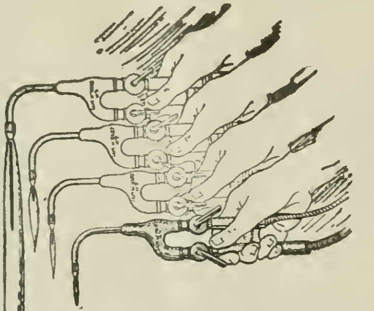
Dyestuff Sales Department:

WILMINGTON DELAWARE

The Du Pont American Industries Are:

E. I. du Pont de Nemours & Co., Wilmington, Del.—Explosives.
Du Pont Chemical Works, New York, N. Y.—Pyroxylin and Coal Tar Chemicals.
Du Pont Fabrikoid Co., Wilmington, Del.—Leather Substitutes.
The Arlington Works, 725 Broadway, New York, N. Y.—Ivory Py-ra-lin and Cleanable Collars.
Harrison Works, Philadelphia, Pa.—Paints, Pigments, Acids and Chemicals.
Du Pont Dyestuffs Works, Wilmington, Del.—Coal Tar Dyestuffs.

DU PONT



$AVE More Hours
For Hours Mean $$$

Hoke-Phoenix BRAZING, PRE-HEATING and SOLDERING outfits, using oxygen and ordinary gas—Ten Times Faster.

Hoke-Phoenix LEAD BURNERS, safe, fast and more economical.

Hoke-Phoenix Reducing Valves or Regulators for oxygen, hydrogen and acetylene.

IMMEDIATE DELIVERIES.
Circular Free.

SAM W. HOKE, Mgr.
12-16 John St., N. Y.

Tank Cars and Tanks

NINE ALL STEEL TANK CARS, CLASS 2 TYPE, 6,000 gallon. Perfect physical condition.

5 Open Top, 10′ dia. x 10′ high, ¼″
15 8′ dia. x 15′ high, 5/16″ shell, ⅜″ dished heads. Pfandler blue gray, enamel lined, covered by hermastic enamel. Fine condition.

R. C. LUTY, 15 Park Row, N. Y. C.
BARCLAY 8180

HELP WANTED

WANTED: Chemist in large city in Great Lakes District. One familiar with the distillation of hydro-carbon oils and tars. State experience and salary desired. A. S., c/o Chemical Engineer.

WANTED Competent Chemist. One thoroughly familiar with the distillation of tar oils. State experience and salary desired. The Jennison-Wright Company, Toledo, Ohio.

Removes War Restrictions

Use of Platinum Now Permitted Without License—Fireworks Manufacture Allowed.

An important step toward a return to pre-war conditions in certain industries has been taken by Van. H. Manning, Director of the Bureau of Mines of the Department of the Interior, in modifying the restrictions recently placed on the manufacture and sale of fireworks and of chemicals used in the manufacture of explosives, and on the use of platnium, iridium, and palladium in the manufacture of jewelry and for dental and other non-military purposes. Under the order as modified, licenses will no longer be required in connection with the handling of fireworks or the precious metals named. Many of the numerous chemical elements entering into the manufacture of explosives are used constantly for other commercial purposes, and under the new order no restrictions will obtain on the handling of these chemicals when not used in the manufacture of explosives. Licenses are still required for the handling of all such ingredients when intended to be used in explosive manufacture, however.

German instrument makers at the outbreak of the war had succeeded in impressing the rest of the world with their skill to such an extent, that when the supply of German instruments was cut off, buyers imagined for a time that they would have to go without. But American manufacturers of scientific instruments rose to the occasion to such an extent that today American chemists manage to get along quite well without the output of the German factories. A trip through the showrooms of the Scientific Utilities Co., Inc., of New York City, is quite sufficient to prove that conclusively.

The Riche Adiabatic Calorimeter

The world has become familiar with the application of the vacuum principle as a non-conductor of heat in the various thermal bottles that keep liquids hot or cold for hours and days.

In the Riche Adiabatic Calorimeter this principle has been made use of for scientific purposes. Even in the crude apparatus of the thermal bottle the vacuum cup prevents the penetration of either a higher or lower temperature. In the Riche Calorimeter the vacuum cup principle is reinforced by the use of all other methods of preventing heat transmission.

To prevent any loss or gain of heat through the vacuum cup—which is merely a theoretical premise—it is surrounded by a mahogany box lined with one inch of pressed cork glued to the wood.

ACME TANKS

ANY SIZE OR SPECIFICATION

Three factories, situated in the East, Middle West and Pacific Coast, enable us to give you special service in the manufacture of tanks

We have on hand reserve supplies of air-dried woods suited for the different chemical requirements, making prompt shipments possible.

Our many years' experience in handling tanks to standard and special specifications should be of value to you. Your specifications will have our immediate and careful attention

ACME TANK COMPANY
37 Cortlandt Street, New York City Telephone: Cortlandt 2520

NEW PUBLICATIONS

ANNUAL CHEMICAL DIRECTORY OF THE UNITED STATES. *B. F. Lovelace, Consulting Editor; Charles C. Thomas, Managing Editor.* Baltimore, Md.: William and Wilkins Company. 1918. Pp. 534. Price, $5.00 net postpaid.

The publishers and editors of this useful directory have kept pace with the developments in the chemical industries of the country during the year past and have made marked improvements in this, the second edition of the directory issued.

The directory now contains first of all a very complete listing according to products manufactured of the names and addresses of all American manufacturers of acids, alkalies, colors and dyes drug products, explosives, extracts, fertilizer constituents, oils, preservatives and many other chemicals essential for laboratory, technical and industrial purposes. This list is supplemented by an alphabetically arranged list of the manufacturers and dealers.

Another section of the directory is devoted to chemical engineering supplies and equipment, another to giving the names and location of analytical and consulting chemists, chemical engineers, listed first geographically and then alphabetically, a directory of the technical and scientific societies located in the United States and in foreign countries, a somewhat similar list of publications, American and foreign.

This directory should prove very useful both to the buyers of chemical equipment and supplies and those with either goods, equipment or services to sell, who wish to reach the chemical industries of the country.

HIGH EXPLOSIVES. *By Capt. E. De W. S. Colver, Dr. Met. F.C.S., A.I.A.E.* New York: D. Van Nostrand Company. 1918. Pp. 776. Price, $20.00.

The enterprise of the publishers of this volume is to be commended. As is pointed out in the preface to the book, English technical literature is sadly deficient when it comes to giving information regarding high explosives. While this deficiency became painfully obvious, as many chemists will vouch, on the outbreak of war, even today there exists very little collected information dealing with this very important topic. A chemist anxious to collate information regarding high explosives was compelled to manage as best he could by making use of his own notes gathered in the course of his experimental work and making extracts from the various chemical journals. The publication of this volume will therefore fill a gap which has long been in need of filling.

The author does not attempt to deal with all high explosives in this volume, but excludes certain compounds near the border line, including nitroglycerine, the dynamites, etc., and confines himself principally to those subjects which have in the past been neglected. He deals also with certain subsidiary used in the manufacture of high explosives in a way which, thanks to his ripe experience, will be found interesting and new.

A feature of the volume which will prove interesting to most chemists is the thorough way in which the author deals with certain explosives not yet manufactured on a commercial scale, but which are no doubt destined in the not far distant future to play more important parts in the field of explosive manufacturing.

Bringing together as it does a vast collection of information on the subject of high explosives, information hitherto for the most part unavailable to the chemist and the student, this new volume cannot help but assist the cause of further research.

C. L. PARKER
Chemical Patents
TRADE-MARKS
UNFAIR COMPETITION
McGill Building, Washington, D. C.

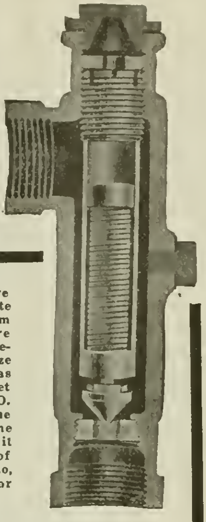
ANALYTICAL AND CONSULTING CHEMIST
MATERIALS ANALYZED—RESEARCH WORK.
FACTORY PROCESSES INVESTIGATED.
FRED'K J. AUSTIN, 119 Nassau St., N. Y. C.

CHEMICAL MAGAZINES
BACK COPIES OF DOMESTIC AND FOREIGN PERIODICALS FOR SALE. WE BUY SETS, VOLUMES, AND NUMBERS.
B. LOGIN and SON
152 EAST 23rd STREET, NEW YORK CITY

Hugo Mock *Asher Blum*
Mock & Blum
PATENTS AND TRADE MARKS
CHEMICAL PATENTS A SPECIALTY
220 BROADWAY
NEW YORK CITY

DESIGNS FOR CHEMICAL BUILDINGS
AND COMPLETE EQUIPMENTS
MILL ENGINEER
Frank Sutton
80 BROADWAY, N. Y. C.
Established 1897 Tel. Rector 960

The Reed Laboratories
RESEARCH AND ANALYTICAL
SPECIALIZING IN LEATHER
TANNING AND DYEING MATERIAL
227 Fulton Street, New York, N. Y.



Why Waste Steam?

If steam were cheap and there were no SARCOS to be had, waste could be tolerated. But steam costs more today than ever before—hence the need for the positive-acting SARCO. Smaller in size and far lower in cost, yet fully as efficient as the best float or bucket trap made—that's the SARCO. A heavy hydrocarbon oil is the acting agent on this trap's one moving part; it won't leak and it never sticks. Over a million of the type in use today. You, too, need them. Particulars of our trial offer on request.

SARCO COMPANY, Inc.
Woolworth Building, New York City
Ellicott Square, Buffalo New Telegraph Bldg., Detroit
Drexel Bldg., Philadelphia Monadnock Block, Chicago
and representatives in all principal cities
Canada: Peacock Brothers, Montreal

RICHE' ADIABATIC CALORIMETER

Renders exact determinations of caloric and combustion contents. Sold by first class dealers of laboratory supplies. We will gladly send catalog.
We also manufacture light machinery, interchangeable parts, stampings, etc., on special order.

Merit Machine Manufacturing Corporation
465 Greenwich Street, New York

B. JURIST, Chemical Director
Formerly with N. Y. Dept. of Health
PHONE: BARCLAY 6987

Research Laboratories, Incorporated
19 PARK PLACE, NEW YORK
CONSULTING and ANALYTICAL CHEMISTS
CONSULTING SANITARIANS

CHEMICAL and BACTERIOLOGICAL EXAMINATIONS
SANITARY and INDUSTRIAL INVESTIGATIONS

A chart which describes in a most graphic way, by means of diagrams, analyses and comparative tables, the sources, properties and physiological effects of the various gases found in mines, compiled by G. A. Burrell of the Bureau of Mines has been issued by the Department of the Interior, Washington.

Classified Index of Advertisers

(Alphabetical Index on Page 443)

Acid Eggs, Stoneware.
Knight, Maurice A. 481

Automatic Liquid Scales.
John Simmons Company 468

Bags, Safety.
Arkell Safety Bag Company 472

Blowers, Fan and Positive Pressure.
Abbe Engineering Company 475
Beach-Russ Company 475

Bolting Cloth, Silk.
Abbe Engineering Company 475
Beach-Russ Company 475

Books, Scientific.
Login & Son 471
Van Nostrand Company 482

Brick, Acid Proof.
Knight, Maurice A. 481

Calorimeters.
Merit Machine Manufacturing Company 471

Castings, Chemical.
Jacoby, Henry E. 482

Centrifuges.
United States and Cuban Allied Engineering Corp. 480

Chemicals.
Baker, J. T., Chemical Co. 477
Baker & Adamson Chemical Company 479
Brenner & Company 482
Garriques, Chas. A., Company 441
Kaltenbach & Bullock 474
Metallurgical Chemicals Corporation 468
Richard, M. W. 474
Virginia Smelting Co. 441

Chemists and Chemical Engineers.
Austin, Fred J. 471
Davis, Charles B. 476
Gilbert Laboratories 482
Research Laboratories 471
Reed Laboratories 471

Chlorinators.
Wallace & Tiernan 472

Chlorine Control Apparatus.
Wallace & Tiernan 472

Color Testing Equipment, Ultra Violet Ray.
R. U. V. Company 473

Compressors, Air or Gas.
Beach-Russ Company 475

Cooling Towers.
Hart, Jr., B. Franklin & Co. 482

Dyestuffs.
Dupont de Nemours, E. I. & Company 469
Metz & Company, H. A. 474
National Aniline and Dye Company 446

Dryers, Centrifugal.
United States and Cuban Allied Engineering Corp. 480

Engineers, Construction.
Sutton, Frank 471

Evaporating Dishes.
Knight, Maurice A. 481

Evaporators.
Jacoby, Henry E. 482

Filter Presses.	
Abbe Engineering Company	475
Jacoby, Henry E.	482
Johnson Co., John	478
Lungwitz, Emil E.	444
Shriver & Company, T.	476
Filters, Suction, Stoneware Acid Proof.	
General Ceramics Company	443
Knight, Maurice A.	481
Fused Silica.	
Sidio Company of America	478
Gas Machines.	
Detroit Heating & Lighting Company	472
Tirrill Gas Machine Company	Front cover
Gas Control Apparatus.	
Wallace & Tiernan	482
Gaskets.	
Sarco Company	443
Gauges, Recording, Indicating, Pressure and Draft.	
Uehling Instrument Company	Inside cover
Glass Cloth and Wool.	
Reuche & Company, L.	474
Heating Apparatus and Systems.	
Sarco Company	470
Hydrometers.	
Gottwick, Scheffer & Company	471
Intermediates.	
Dupont de Nemours, E. I. & Company	469
Metz & Company, H. A.	474
National Aniline and Dye Company	446
Laboratory Apparatus and Caseware.	
Detroit Gas Machine Company	470
Gottwik Scheffer Company	468
Richard, M. W.	474
Rudich Scientific Apparatus Co.	442
Scientific Utilities Company	442
Tirrill Gas Machine Company	Front cover
Machinery, Crushing, Grinding and Pulverizing.	
Abbe Engineering Company	475
Machinery, Metallurgical and Mining.	
Abbe Engineering Company	475
Lungwitz, Emil E.	444
Machinery, Mixing and Kneading.	
Abbe Engineering Company	445
Mills, Ball and Pebble.	
Abbe Engineering Company	475
Oil Coolers.	
Hart, Jr., B. Franklin & Co.	482
Oxygen.	
Beseler Oxygen Company	472
Patents.	
Mock & Blum	471
Parker, C. L.	468
Pumps, Acid or Acid Gases.	
Abbe Engineering Company	475
Beach-Russ Company	475
Pumps, Centrifugal.	
Abbe Engineering Company	475
Pumps, Rotary, Oil or Water.	
Abbe Engineering Company	475
Pumps, Stoneware, Acid Proof.	
General Ceramics Company	443
Knight, Maurice A.	481
Pyrometers.	
Uehling Instrument Company	Inside cover
Recorders Co.	
Uehling Instrument Company	Inside cover
Regulators, Pressure and Temperature.	
Sarco Company	471
Safety Bags.	
Arkell Safety Bag Co.	472
Sterilizers, Ultra Violet Ray.	
R. U. V. Company	473
Sterilizing Equipment, Water.	
Wallace & Tiernan	482
Stoneware, Chemical.	
General Ceramics	443
Knight, Maurice A.	481
Syphons, Stoneware.	
Knight, Maurice A.	481
Tanks, Cyanide.	
Acme Tank Company	468
Tanks, Stoneware, Acid Proof.	
General Ceramics Company	443
Knight, Maurice A.	481
Tanks, Wood.	
Acme Tank Company	468
Thermometers.	
Gottwik, Scheffer & Company	468
Tower Packing Acid Proof Stoneware.	
Knight, Maurice A.	481
Towers, Acid Stoneware.	
General Ceramics Company	443
Knight, Maurice A.	481
Towers, Water Cooling.	
Hart, Jr., B. Franklin & Company	482
Traps, Steam and Radiator.	
Sarco Company	443
Ultra Violet Lamps.	
R. U. V. Company	473
Valves and Cocks, Acid Proof Stoneware.	
General Ceramics Company	443
Knight, Maurice A.	481
Vats, Wood.	
Acme Tank Company	468
Zinc Plates, Sheet and Dust.	
New Jersey Zinc Company	445

H. M. Freeburn has resigned as assistant engineer of the Pennsylvania State Department of Health to become associated with the engineering staff of Wallace & Tiernan Co., Inc., New York City, manufacturers of chlorine control apparatus and sanitary engineering specialties.

Dr. Arthur L. Day has resigned as director of the Geophysical Laboratory, Carnegie Institution of Washington, to do research work for the Corning Glass Works, Corning, N. Y.

The Alba Chemical Company, Inc., Manhattan, has been incorporated with an authorized capital of $75,000, and a charter permitting it to manufacture chemicals, alkalies and drugs. The incorporators are H. B. Holland, 108 Prospect Place; R. A. Maclean, 318 74th Street, Brooklyn, and A. H. Dickinson, 37 Wall Street, New York City.

The Hanover Chemical Works, Manhattan, have been incorporated with a capital of $100,000.

BECKMANNS
THERMOMETERS
NORMAL, ALLIHN'S & ANSCHUTZ
Gottwik, Scheffer & Co.
25 Church Street, NEW YORK
HYDROMETERS
CALORIMETER

New Jersey Testing Laboratories
Operate extensive experimental plant for trying out new processes on the large scale. Special arrangements made for the demonstration and commercial development of chemical products and processes.
92-98 Greenwood Avenue MONTCLAIR, N. J.

OXYGEN

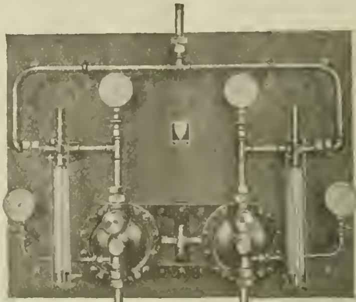
TO FILL PRESENT NEEDS WE ARE SUPPLYING OXYGEN IN LOW PRESSURE TANKS TO ACCOMMODATE THE TRADE WHO DO NOT REQUIRE LARGE QUANTITIES OF GAS IN ONE SHIPMENT.

BESELER OXYGEN CO.
131-133 E. 23rd St., N. Y. C.

Gas for—
laboratory and industrial uses
—automatically made
by the
Detroit Combination Gas Machine
Descriptive catalogue and names of users in your vicinity sent on request.
Detroit Heating & Lighting Co.
616 Wight Street, Detroit, Mich.
Established 1868

"Detroit"
Laboratory Burner

The Control of Gases



We are specialists in the control, measurement, application and proportioning of gases. The cut above shows one type of equipment developed to combine in predetermined proportion two gases of totally different properties.

W & T EQUIPMENT
For Gas Control

is constructed with the same care and attention to minute detail that has distinguished "W & T" Chlorine Control Apparatus for Water and Sewage Purification.

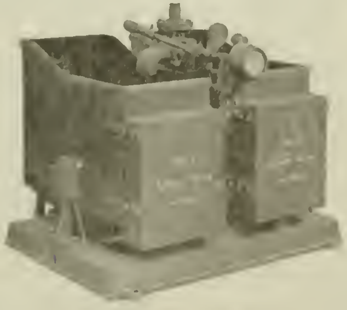
Our Engineering Staff is prepared for Consultation on problems of Gas Control.

Wallace & Tiernan Co., Inc.
349 Broadway, New York City

HERMAN A. HOLZ
2 East 24th Street, New York

Producers of
Molybdic Acid 88%
Ammonium Persulphate

WRITE FOR SAMPLES AND QUOTATIONS



"MORE THAN A METER"
The Improved Leinert Automatic Liquid Gravity Scales
(PATENTED)

A Simple-Positive Mechanical Balance for Recording by Weight. Recommended for WATER—JUICES—BRINE—CAUSTIC SOLUTIONS and LIQUIDS of all descriptions.

Not Affected by Temperature Changes or Variations in Specific Gravity. Special Scales to Meet Your Requirements. WRITE US YOUR SERVICE CONDITIONS.

JOHN SIMMONS COMPANY
107-111 Centre Street :: New York City

(*Continued from page* 464)

there is a diminution in the number of the finer bands. The bands observed are much wider and more diffuse, especially in the bromine derivatives. This is supposed to be due to the damping neutralisation of the fundamental oscillations of the nucleus. When the amino-group is introduced, the complex oscillations are completely neutralised, and a single large absorption bands takes the place of the numerous bands exhibited by aniline and phenol.

Ethereal Oils.

The ultra violet absorption of a number of ethereal oils and synthetic organic substances has been examined by *Pfluger* (Physikal. Zeitsch., 1909, *10*, 406). A mercury lamp was used as radiator, a thermopile as indicator and the substances were examined in thin layers between quartz plates. The percentage absorption values for various lines are tabulated.

Purity of Terpenes.

Hantzsh (Ber., 1912, *45*, 553) shows that the purity of the terpenes is best controlled, and the compounds themselves best characterized, by means of their ultra violet absorption spectra. When the terpenes are not quite pure, fractions differing in b.p. by only 0.1° often show considerable differences in the form and position of their absorption curves. The absorption curves of the following compounds in alcoholic solution are recorded: a—pinene, d— and l—limonene, dipentene, l—a—phellandrene, B—phellandrene, sylvestrene, caryophyllene, m—and p—cymene, d— and l—camphor, d— and l—borneol, d— and l—laurinol. It is found that all these substances, with the exception of m— and p—cymene, a—phellandrene, d— and l—laurinol, and caryophyllene, show general absorption, and that solutions of the terpenes and camphors do not conform to Beer's law, the absorption of equimolecular solutions increasing slightly with the dilution. The power of absorption increases as the contiguity of the double linkings becomes more pronounced. Dipentene, d—, l—, and i—limonene show slight differences in their absorption curves, but these are probably due to the presence of difficulty removable impurities.

Bielecki and *Henri* have measured the absorption of ultra violet rays by aliphatic alcohols, acids, esters, aldehydes and ketones. (Compt. rend. 1912, 155, 456). The alcohols tested show a continuous and increasing absorption from $\lambda = 3{,}000$ to $\lambda = 2{,}144$, which augments rapidly with the number of $.CH_2.$ groups in the molecule. The monobasic acids show an absorption about 2,000 times as great as that due to methyl alcohol. Oxalic acid produces an absorption 30,000 times as great as that of methyl alcohol, but when the two $\cdot CO_2H$ groups are separated by one or more $\cdot CH_2\cdot$ groups, the absorption is about fifteen times as great as that of the monobasic acids.

available in your own Laboratory

Every Chemical Laboratory should be equipped with a source of Ultra Violet Rays.

The R. U. V. Ultra Violet Ray Lamp is especially recommended to those chemists who have failed to get desired results with the ordinary form of lamp.

POINTS OF SUPERIORITY OF R. U. V.

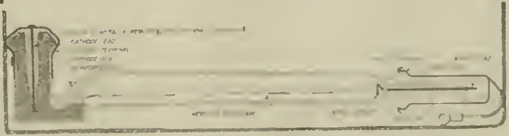
As an indication of its superiority, it has been proven that the R. U. V. Lamp yields twice the usual ultra violet component.

The increased radiation insures rapid developments of possible reactions.

The lamp is adaptable to various kinds of vessels. High efficiency is assured by manufacture of frame from new and clear quartz exclusively.

There is perfect electrical control.

THE R. U. V. CO., Inc.
NEW YORK CITY



CHEMICALS
COLORS
MINERALS

For the following Trades:

RUBBER
PAINT
TEXTILE
POTTERY
OIL CLOTH
PAPER
PRINTING INK
LEATHER

KATZENBACH & BULLOCK CO.

New York Trenton Chicago
Boston San Francisco

BOTTLED GOODS
Made More Attractive

Whatever you put up in bottles, whether for the table or the medicine cabinet, or perfume, you can get the merchandizing value of a more attractive bottle by using "Elarco Velvo."

This is a new, remarkable discovery that enables the frosting or dimming of cheap glass bottles, so that they look like expensive, well-made containers, not hydrofluoric acid; no danger to hands or apparel; a few cents per gross to apply; the cheapest way of solving the problem of the high cost of containers, if you use glass. Write at once.

L. REUSCHE & CO. 12 Barclay Street
NEW YORK CITY

Caustic Potash **U.S.P. Sticks**
C.P. Lumps

Dyes, Chemicals and Laboratory Supplies

Used Steel and Iron Drums, All Sizes
Carboys, Immediate Delivery

M. W. RICHARD
Beekman 3987
154 Nassau Street New York City

H. A. METZ & CO., Inc.

122 HUDSON STREET, NEW YORK

BOSTON PHILADELPHIA SAN FRANCISCO ATLANTA
PROVIDENCE CHICAGO CHARLOTTE

PRODUCTS:

Dyestuffs, Colors, Intermediates, Sizing and Finishing Materials

Dyestuffs, Colors, Sizing and Finishing Materials — *Produced by* — Consolidated Color and Chemical Co. Newark, N. J.

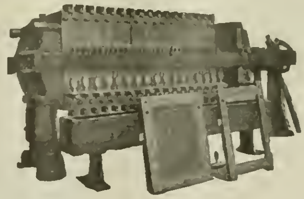
Dyestuffs and Intermediates — *Produced by* — Central Dyestuff and Chemical Co. Newark, N. J.

"PROVO" Filter Presses

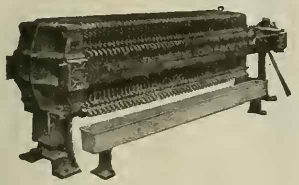
For the efficient recovery of solids from liquids and the thorough treatment and washing of same. For Clarifying Oils, Varnishes, Fruit Juices, etc.

Especially Designed for

Dyes and Intermediates



Wood Press for Acid Solutions



Metallic Press for General Service

Consult our Engineers relative to Your Especially Difficult Filtration Problems

Full Data on Request

Provost Engineering Corporation

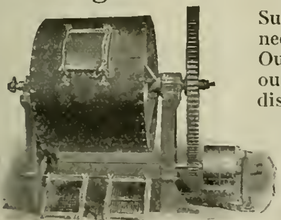
Works, Brooklyn, N. Y. 218-220 Broadway, New York

ABBÉ

BALL AND PEBBLE MILLS

(PATENTED)

30 Designs 59 Sizes

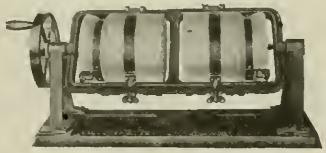


ABBÉ BALL OR PEBBLE MILL
(Patented)

Submit your PROBLEMS to our Engineers who will be ready to help you. Our years of experience as well as our Testing Laboratory are at your disposal.

WE ALSO MANUFACTURE
TUBE MILLS, DISINTEGRATORS,
ROTARY CUTTERS OR SHREDDERS

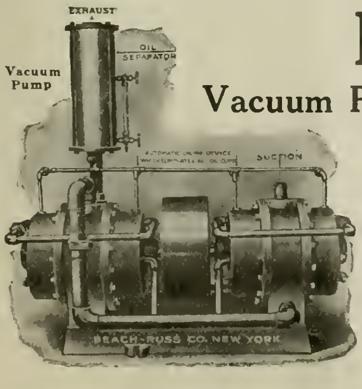
Send for Bulletins



ABBÉ LABORATORY MILL

ABBÉ ENGINEERING CO.

Broadway and Ann Street
Phones: Cortlandt 54-55-56
NEW YORK CITY



BEACH-RUSS

Vacuum Pumps and Positive Pressure Blowers

(Patented)

Noiseless as a motor. Durable.
Simple as a wheel. Reliable.
Strong. Could you ask more?

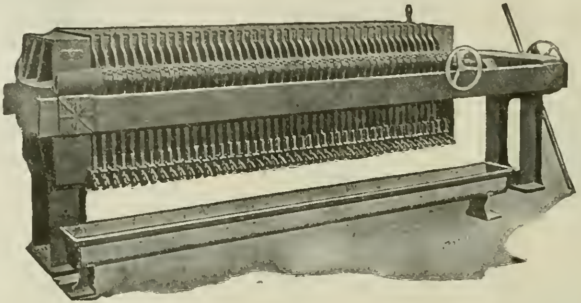
Compound High-Vacuum Pumps guaranteed to exhaust to *within one-tenth inch of the barometer.* Single-Stage Vacuum Pumps guaranteed to show 27 in. or more on the mercury column, the barometer being at 30 in. Automatic oiling device. No gears or complicated parts. Positive Pressure Blowers built on the same high standard.

Also Acid Pumps, Filter Presses, Pulverizing Machinery

BEACH-RUSS CO., 220 Broadway, New York
Phones
Cortland 54, 55 and 56

Shriver Filter Presses

FOR ALL PURPOSES



SIDE FEED FILTER PRESS

FILTER PRESS PUMPS

FILTER CLOTH AND PAPER

SEND FOR CATALOG "B"

T. SHRIVER & COMPANY

Office and Works: 812 Hamilton Street
HARRISON, NEW JERSEY

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

Any commercial product reproduced.

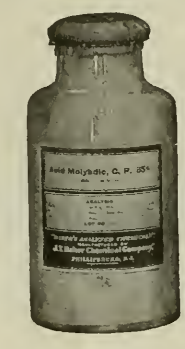
Working Formulas Furnished

FOR
MANUFACTURERS
AND CHEMISTS

ALL questions, materials for analysis, or letters leading to the opening of negotiations for special chemical research work, will receive prompt attention if addressed to—

DR. CHARLES B. DAVIS
469 West 152nd Street
New York City

On Your Next Chemical Order—



SPECIFY

"Baker's Analyzed" Chemicals and Acids

After a trial you will specify them on ALL your orders, because you will find them dependable reagents of the highest quality and uniformity.

An Accurate Analysis Appears on the Label of Each Bottle

Catalog on Request

J. T. BAKER CHEMICAL CO.
PHILLIPSBURG, N. J.

Our New Factory for the Manufacture of Pure Fused Silica, known as

SIDIO

has just been opened in New York City. A part of the output has already been assigned to the Government, but production is on such a scale as will enable us to meet your needs promptly.

SIDIO Ware is coming into wide use, both because of its low cost compared to platinum and other wares which it replaces, and also because of its technical superiority.

SIDIO withstands rapid temperature changes, it may be exposed to a continuous temperature of 1200° C. SIDIO has a coefficient of expansion one-seventeenth that of glass or platinum.

SIDIO is especially adapted for Combustion and Pyrometer Tubes, Sulphuric and Nitric Acid Condensing and Cooling Apparatus, high temperature gas analyses.

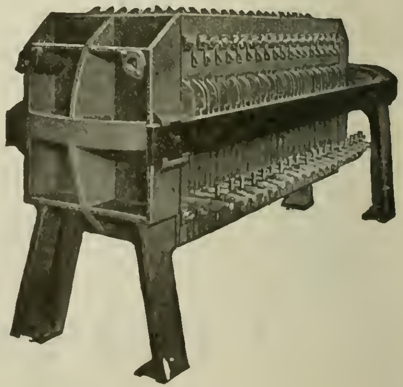
SIDIO is an American-made Product. Manufactured under American Patents. When you order fused silica SPECIFY SIDIO.

THE SIDIO COMPANY OF AMERICA, Inc.
37-39 MURRAY STREET, NEW YORK CITY

15,000 "Johnson" Filter Presses

NOW IN USE

The "Johnson" Diaphragm Pump



All Types, All Sizes
Made of
Iron, Bronze, Lead, Aluminum,
Tin and Wood,
also
Belt, Steam and Electrically
Driven
Filter Press Pumps
and
Turbine Mixers

Backed by Forty Years' Experience

John Johnson Company
37th Street and Second Avenue, Brooklyn, N. Y.

Chemically Pure

LABORATORY REAGENTS

Chemically Pure

ACIDS

Hydrochloric Acid, sp. gr. 1.19	***Nitric Acid, sp. gr. 1.42***
Sulphuric Acid, sp. gr. 1.84	***Acetic Acid, 99.5%***

Ammonia Water

sp. gr. 0.90

WE manufacture and carry in stock a full line of Chemically Pure analytical reagents. These reagents do not require preliminary testing, and the results obtained by their use are accurate.

Our Products will be furnished by the leading Supply Houses, if B. & A. Chemicals are specified on orders.

LIST FURNISHED ON REQUEST

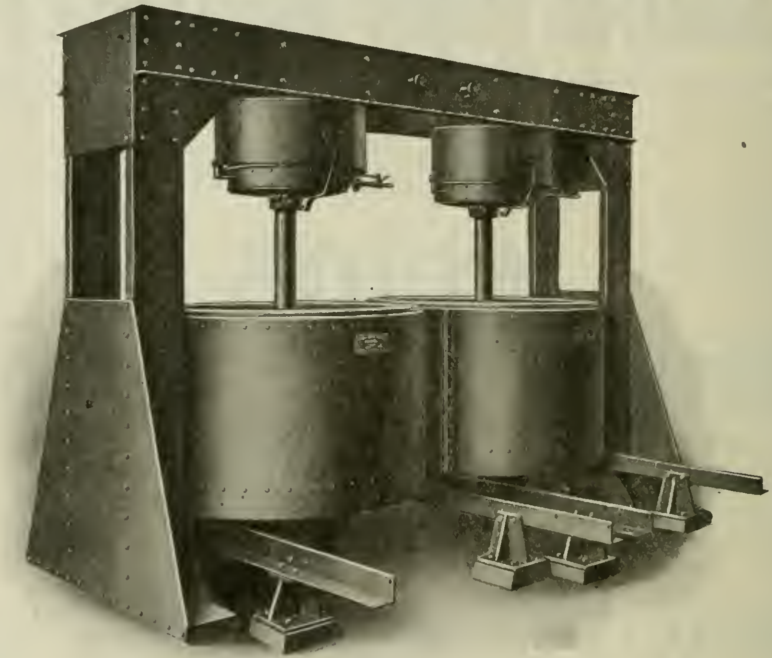
The

Baker & Adamson Chemical Company

EASTON, PENNA.

Centrifugals

FOR THE CHEMICAL INDUSTRY



The above illustration shows two of our latest improved 42-inch specially designed standard Weston Centrifugal Machines for service in the manufacture of Explosives and Sulphate of Ammonia (coke oven by-product).

We specialize in direct connected, electric motor-driven water- and belt-driven centrifugals. They are designed with a minimum number of parts and are of simple and rugged construction with few lubrication points. Sizes from 30 inches to 72 inches in diameter.

Complete specifications on request.

UNITED STATES & CUBAN ALLIED WORKS ENGINEERING CORPORATION

NEW YORK OFFICE
50 Broad Street

Factories
BRADFORD, Pa HAVANA, Cuba

HAVANA OFFICE
Cuba 84

LIQUID SULPHUR DIOXIDE

MADE BY

VIRGINIA SMELTING CO.

SOLD BY

CHAS. F. GARRIGUES COMPANY

ALSO MANUFACTURERS' AGENTS FOR

CAUSTIC POTASH, FIRST SORTS—88/92% LIQUID, 45° BÉ., AND USP STICKS—BARIUM BINOXIDE—BARIUM CARBONATE—STEARATE OF ZINC—TRISODIUM PHOSPHATE—STEARIC ACID.

80 MAIDEN LANE, NEW YORK CITY

C.P.N. CHEMICAL CO.
Covers the Country
"We Serve and Save"
NEW YORK
PHILADELPHIA CHICAGO
CLEVELAND PITTSBURGH
ATLANTA SAN FRANCISCO

EXCLUSIVE SALES AGENTS FOR

NEVIN CHEMICAL CO.

St. Louis, Mo.

MANUFACTURERS OF

Barium Binoxide
Barium Oxide
Barium Sulphide
Barium Nitrate
Barium Carbonate
Barium Chloride
Barium Sulphate, Dry and Pulp
Sodium Sulphide 60/62
Sodium Nitrite 99%
Sodium Nitrate Ref.

C P N CHEMICAL CO., Inc.

Department O

Industrial Chemicals

80 Reade St.
New York

227 W. Huron St.
Chicago

Chemical Bldg.
St. Louis, Mo.

Rector Chemical Co., Inc.

Office, 2 Rector St.,
NEW YORK CITY

Manufacturers of

METOL (Rector)
PARA AMIDO PHENOL HYDROCHLORIDE

and other photographic chemicals and intermediates.

Distributors of

PARA NITRO PHENOL
ORTHO NITRO PHENOL
PHTHALIC ANHYDRIDE
PARAPHENYLENEDIAMINE

and other chemicals.

Our New Factory for the Manufacture of Pure Fused Silica, known as

SIDIO

has just been opened in New York City. A part of the output has already been assigned to the Government, but production is on such a scale as will enable us to meet your needs promptly.

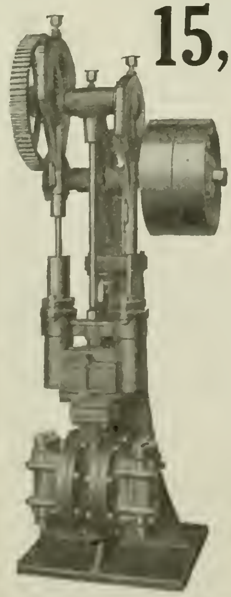
SIDIO Ware is coming into wide use, both because of its low cost compared to platinum and other wares which it replaces, and also because of its technical superiority.

SIDIO withstands rapid temperature changes, it may be exposed to a continuous temperature of 1200° C. SIDIO has a coefficient of expansion one-seventeenth that of glass or platinum.

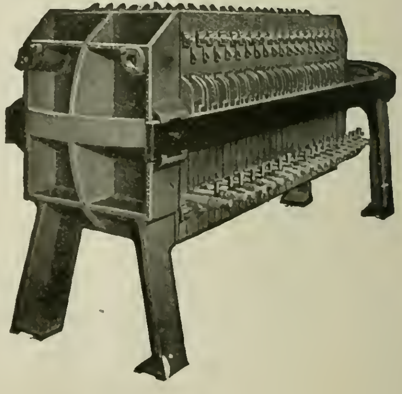
SIDIO is especially adapted for Combustion and Pyrometer Tubes, Sulphuric and Nitric Acid Condensing and Cooling Apparatus, high temperature gas analyses.

SIDIO is an American-made Product. Manufactured under American Patents. When you order fused silica SPECIFY SIDIO.

THE SIDIO COMPANY OF AMERICA, Inc.
37-39 MURRAY STREET, NEW YORK CITY



The "Johnson" Diaphragm Pump



15,000 "Johnson" Filter Presses

NOW IN USE

All Types, All Sizes
Made of
Iron, Bronze, Lead, Aluminum,
Tin and Wood,
also
Belt, Steam and Electrically
Driven
Filter Press Pumps
and
Turbine Mixers

Backed by Forty Years' Experience

John Johnson Company
37th Street and Second Avenue, Brooklyn, N. Y.

Chemically Pure

LABORATORY REAGENTS

Chemically Pure

ACIDS

Hydrochloric Acid, sp. gr. 1.19
Sulphuric Acid, sp. gr. 1.84
Nitric Acid, sp. gr. 1.42
Acetic Acid, 99.5%

Ammonia Water

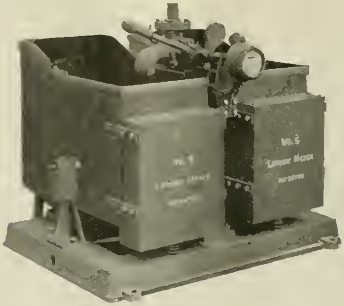
sp. gr. 0.90

WE manufacture and carry in stock a full line of Chemically Pure analytical reagents. These reagents do not require preliminary testing, and the results obtained by their use are accurate.

Our Products will be furnished by the leading Supply Houses, if B. & A. Chemicals are specified on orders.

LIST FURNISHED ON REQUEST

The
Baker & Adamson Chemical Company
EASTON, PENNA.



"MORE THAN A METER"

The Improved Leinert Automatic Liquid Gravity Scales

(PATENTED)

A Simple-Positive Mechanical Balance for Recording by Weight. Recommended for WATER—JUICES—BRINE—CAUSTIC SOLUTIONS and LIQUIDS of all descriptions.

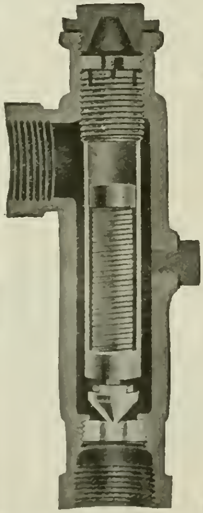
Not Affected by Temperature Changes or Variations in Specific Gravity. Special Scales to Meet Your Requirements. WRITE US YOUR SERVICE CONDITIONS.

JOHN SIMMONS COMPANY

107-111 Centre Street :: New York City

You can always depend on the action of the

Steam Trap SARCO

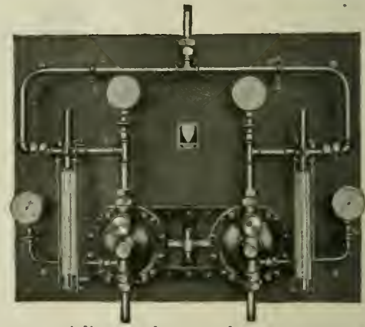


The SARCO never fails, never leaks, and it shuts off all the steam at the right time. SARCO trapped lines are not the kind calling for constant attention and expensive repairs. A heavy hydrocarbon oil operates the only moving part of this steam trap. It is the smallest trap made and the cheapest; drainage capacity is tremendous. Guaranteed for any pressure up to 200 lb.

30 days' free trial for the skeptical. Write!

Sarco Company
Incorporated
Woolworth Bldg., New York City

The Control of Gases



We are specialists in the control, measurement, application and proportioning of gases. The cut above shows one type of equipment developed to combine in predetermined proportion two gases of totally different properties.

W & T EQUIPMENT For Gas Control

is constructed with the same care and attention to minute detail that has distinguished "W & T" Chlorine Control Apparatus for Water and Sewage Purification.

Our Engineering Staff is prepared for Consultation on problems of Gas Control.

Wallace & Tiernan Co., Inc.
349 Broadway, New York City

HERMAN A. HOLZ

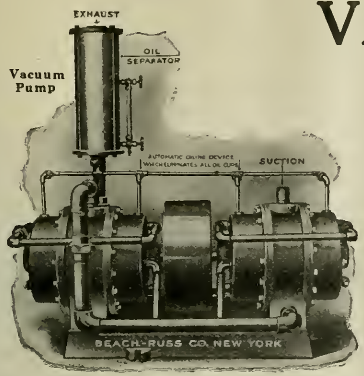
2 East 24th Street, New York

Producers of

Molybdic Acid 88%

Ammonium Persulphate

WRITE FOR SAMPLES AND QUOTATIONS



VACUUM PUMPS
AND
PRESSURE BLOWERS
(Patented)

Noiseless as a motor. Durable.
Simple as a wheel. Reliable.
Strong. Could you ask more?

Compound High-Vacuum Pumps guaranteed to exhaust to *within one-tenth inch of the barometer.* Single-Stage Vacuum Pumps guaranteed to show 27 in. or more on the mercury column, the barometer being at 30 in. Automatic oiling device. No gears or complicated parts. Positive Pressure Blowers built on the same high standard.

Also Acid Pumps, Filter Presses, Pulverizing Machinery

BEACH-RUSS CO., 220 Broadway, New York Phones Cortland 54, 55 and 56

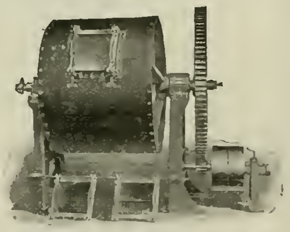
ABBÉ "MAX" MILL
(Patented)
For Grinding Filter Press Cake, Crystals, Colors, Etc.

ABBÉ
Engineering Co.
PULVERIZING MACHINERY

If you have a pulverizing or granulating problem, submit it to our Engineers, who will recommend the proper machine. We have a machine to meet your every need.

We also manufacture Tube Mills, Laboratory Mills, Rotary Cutters or Shredders.

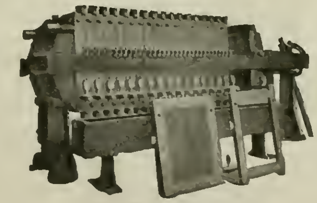
Send for Bulletins


ABBÉ BALL OR PEBBLE MILL
(Patented)
For Wet or Dry Grinding

ABBÉ ENGINEERING CO.
Broadway and Ann Street Phones: Cortlandt 54-55-56 NEW YORK CITY

"PROVO" Filter Presses

For the efficient recovery of solids from liquids and the thorough treatment and washing of same. For Clarifying Oils, Varnishes, Fruit Juices, etc.


Wood Press for Acid Solutions

Especially Designed for
Dyes and Intermediates

Metallic Press for General Service

Consult our Engineers relative to Your Especially Difficult Filtration Problems

Full Data on Request

Provost Engineering Corporation
Works, Brooklyn, N. Y. 218-220 Broadway, New York

Remember the Name

"ABERDEEN"

FOR YOUR REQUIREMENTS ON

Industrial and Textile Chemicals, Dyes and Oils

Glucose, Caustic Soda, Soda Ash (bags and barrels),
Bichromates, Benzoates, Saccharine
U. S. Food Administration License No. G 118,579

ABERDEEN CHEMICAL CO.
200 Broadway, New York City
Telephone: Cortlandt 1127-1128

B. JURIST, Chemical Director
Formerly with N. Y. Dept. of Health
PHONE: BARCLAY 6987

Research Laboratories, Incorporated
19 PARK PLACE, NEW YORK
CONSULTING and ANALYTICAL CHEMISTS
CONSULTING SANITARIANS

CHEMICAL and BACTERIOLOGICAL EXAMINATIONS
SANITARY and INDUSTRIAL INVESTIGATIONS

DESIGNS FOR CHEMICAL BUILDINGS
AND COMPLETE EQUIPMENTS
MILL ENGINEER
Frank Sutton
80 BROADWAY, N. Y. C.
Established 1897 Tel. Rector 960

The Reed Laboratories
RESEARCH AND ANALYTICAL
SPECIALIZING IN LEATHER
TANNING AND DYEING MATERIAL
227 Fulton Street, New York, N. Y.

C. L. PARKER
Chemical Patents
TRADE-MARKS
UNFAIR COMPETITION
McGill Building, Washington, D. C.

BECKMANNS
THERMOMETERS
NORMAL, ALLIHN'S & ANSCHUTZ
Gottwik, Scheffer & Co.
25 Church Street, NEW YORK
HYDROMETERS
CALORMETER

New Jersey Testing Laboratories

Operate extensive experimental plant for trying out new processes on the large scale. Special arrangements made for the demonstration and commercial development of chemical products and processes.

92-98 Greenwood Avenue MONTCLAIR, N. J.

Alphabetical Index to Advertisers

(Classified Index on Page 470)

A

Abbe Engineering Company	524
Aberdeen Chemical Co.	486
Acme Tank Company	527
Arkell Safety Bag Company	487
Austin, Frederick J.	527

B

Bacon, Chas. V.	519
Baker and Adamson Chemical Company	483
Baker Chemical Company, J. T.	525
Beach-Russ Company	524
Beseler Oxygen Company	519
Brenner & Company	Back Cover

C

Consolidated Products Co.	519
C. P. N. Chemical Company, Inc.	481
Cooling Tower Co.	518

D

Davis, Charles B.	525
Detroit Heating & Lighting Company	487
Dupont de Nemours, E. I., Company	515

F

Fleisher, W. L., Co.	517
Florasynth Laboratories	519

G

Garriques Company, Charles F.	481
General Ceramics Company	Back Cover
Gilbert Laboratories	Back Cover
Glander & Co.	516
Gottwik, Scheffer & Co.	486

H

Hart & Company, B. Franklin, Jr.	Back Cover
Hoke, Sam W.	526
Holz, Herman A.	484

J

Jacoby, Henry E., M. E.	Back Cover
Johnston Company, John	482

K

Kaltenbach & Bullock Co.	516
Knight, Maurice A.	Front Cover

L

Login, B., and Son	527
Lungwitz, Emil E	488

M

Machinery Utilities Co	Inside Cover
Metz & Company, Inc., H. A	474
Mock & Blum	523

N

National Aniline and Chemical Company	490
New Chemical Co	481
New Jersey Testing Laboratories	486
New Jersey Zinc Company	489
Normal Allians & Anschutz	486

P

Palo Company	516
Parker, C. L	486
Provost Engineering Company	524

R

Rector Chemical Company, Inc	481
Reed Laboratories	486
Research Laboratories	486
Richard, M. W	519
Rudich Scientific Apparatus Company	
R. U. V. Company, Inc.	521

S

Sarco Company, Inc	484
Shriver & Company, T	525
Sidio Company of America, Inc	482
Simmons Company, John	484
Stanley, W. W	487
Stillwell Laboratories	518
Sutton, Frank	486

T

Tank Equipment Company	487
Tirrill Gas Machine Lighting Company	523

U

Uehling Instrument Company	Inside Front Cover
United States and Cuban Allied Works Engineering Corp.	528

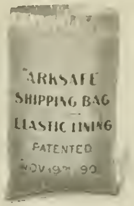
V

Van Nostrand Company, D	Back Cover
Virginia Smelting Company	481

W

Wallace & Tiernan Co., Inc	484

"ARKSAFE"
Elastic
Paper Linings



for Barrels and Bags

Prevent sifting and keep contents clean and dry. Used by largest manufacturers of chemicals, dyes and colors.

SEND FOR SAMPLES

ARKELL
SAFETY BAG
COMPANY
120 Broadway
New York City

THE TANK
EQUIPMENT CO., Inc.

is equipped to furnish

STEEL TANKS
for all Chemical purposes

All tanks are correctly constructed and we can make early shipments. We would be pleased to have you let us know your requirements.

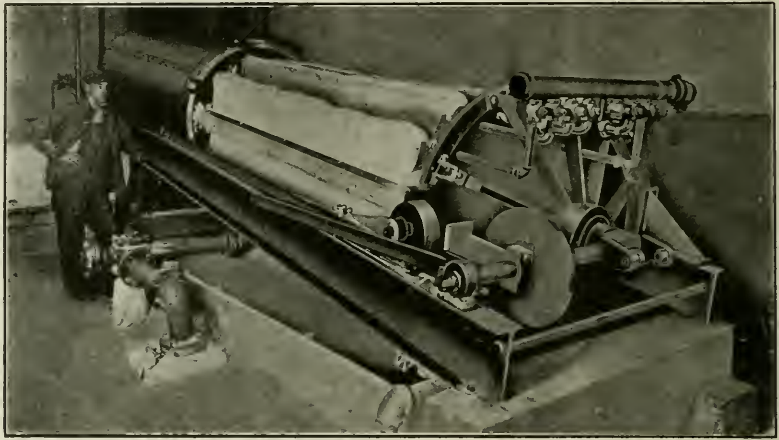
We also have some used equipment which might be of interest to you.

TANK EQUIPMENT CO., Inc.
501 Fifth Avenue
New York, N. Y.
Telephone: Murray Hill 4988-89

KELLY FILTERS

PATENTED

ALL PATENTS OWNED BY UNITED FILTERS CORPORATION
SALT LAKE CITY, UTAH



WE WILL HAVE EITHER GOOD OR BAD TIMES, ACCORDING TO OUR MENTAL ATTITUDE.

THE NEW YEAR WILL LOOK ROSY IF YOUR PLANT IS PROPERLY EQUIPPED WITH LABOR-SAVING MACHINERY.

WE WISH EVERYONE A HAPPY NEW YEAR, AND IF WE CAN HELP THE GOOD CAUSE IN ANY WAY, JUST WRITE AND TELL US YOUR TROUBLES.

EMIL E. LUNGWITZ

LICENSEE

GENERAL AND EXCLUSIVE FOR ALL INDUSTRIES
WITH CERTAIN EXCEPTIONS, IN THE ENTIRE
UNITED STATES EAST OF COLORADO.

90 WEST STREET, NEW YORK, N. Y.

New Jersey
zinc

The World's Standard for Zinc Products

Spelter

There is but one important deposit of Zinc Ore in the world that is free from deleterious impurities. Directly from this uniquely Pure Ore the famous

Horse Head and Bertha
(High Grade)

Spelters are smelted. The brass, bronze and wire manufacturer protects his reputation and maintains the quality of his goods by using these Pure Spelters because **Horse Head** and **Bertha** brands consistently run above 99.94 Percent Pure.

The slab to slab uniformity of these two brands is greater than that of other high grade spelters.

THE NEW JERSEY ZINC COMPANY
55 Wall Street, New York
ESTABLISHED 1848
Chicago: Mineral Point Zinc Company
1111 Marquette Building

TABLE OF CONTENTS

Editorial 491

Southern California Industries Growing.
By Morris M. Rathbun,
Los Angeles Chamber of Commerce.
Forty million dollars have been invested in the chemical industries of California since the outbreak of war in Europe, and the writer of this article tells how it has been done................ 493

Business Men Must Be More Scientific.
Burwell S. Cutler, Chief of Bureau of Foreign and Domestic Commerce, declares war time habits of precision must be carried over into peace times. 495

Lignite Experts Tour United States.
Canadian Scientists Engaged in Taking Survey of Lignite Resources of United States and Canada.. 496

Some Processes of Rubber Manufacturing.
By Frederick J. Maywald, F. C. S.
The writer, an expert on rubber manufacturing, treats of the preparation and mixing of various rubber compounds and the manufacture of various articles 497

The Occlusion of Gases in Metal.
By Alfred W. Porter, D.Sc., F.R.S.
An English scientist discusses some aspects of an interesting series of phenomena 499

Abstracts of Magazine Articles.
British Control of Acid Industry—The Manufacture of Artificial Silk—Chemicals from Seaweeds—Paper Yarn Industry in Europe—The War's Effect on Photographic Supplies........................ 501

Make Paper From Leaves.
Mme. Karen Dramson suggests a new source of paper pulp....................................... 503

Plan to Erect Laboratory.
Canadian Council for Scientific and Industrial Research planning big central research institute.... 503

Mainly About Chemists....................... 504

Ultra Violet Light. Part XX.
By Carleton Ellis and A. A. Wells.
Its Application in the Chemical Arts. 505

Chemical Engineer Index for 1918............ 507
Incorporations 510
Mesothorium and Its Industrial Use. 511
Britain Using Many Substitutes............... 512

American Corporation to Make Caustic in Brazil 512
New Publications 522

Bring Us Your Dyestuff Problems

The application of the dyestuff to textiles is as much an art as the production of the dyestuff.

Dyeing is a chemical, not a mechanical process. An intimate knowledge of the possibilities of every dyestuff is often necessary to meet the particular requirements of the consumer, and the variation of local conditions, due to differences in the quality of water, steam, and chemicals makes the dyehouse problem an individual one.

Because of this individual factor the technique of the application of dyes commands today, as it has done in the past, the best talent among those distributors who cater to the highest class of trade.

The technical department of this Company is manned by chemists who have been picked because of their expert knowledge, practical experience, and demonstrated ability. Well-equipped laboratories are maintained at our different offices, for the service of our customers.

You are invited to submit your problems. Your questions are welcome. Our advice in answer involves no obligation on your part.

National Aniline & Chemical Company
Incorporated

Main Sales Office: 21 Burling Slip, New York

Branches:

Charlotte
Boston
Chicago
Cincinnati
Hartford
Kansas City
Milwaukee
Minneapolis
Philadelphia

Back up the Boys in France—Buy W. S. S. regularly

THE CHEMICAL ENGINEER

Copyright, 1918, by McCready Publishing Company

VOL. XXVI. DECEMBER, 1918 No. 13

Published Monthly by the
McCready Publishing Company.
ROBERT H. McCREADY, President
DAVID R. PERAZZO, Treasurer
118 East 28th Street, New York

ALEXANDER G. SCLATER,
Editor.
CHARLES B. DAVIS, F. C. S., Consulting Editor
H. C. DAYCH, Business Manager

Entered as Second Class Matter at the Post Office at New York, N. Y., under the Act of March 3d, 1879.

Subscription—United States, Cuba and Mexico, $2.00; Canada, $2.50; other countries, $3.00.
Single Copies, 25c.

DECEMBER, 1918

The services of The Chemical Engineer are always at the disposition of its readers: most of them from time to time are confronted by problems, which they find difficult or impossible of solution. At these times may we not offer them our assistance? Perhaps a line or two to us may result in you getting in touch with the man who possesses the information you need.

ECONOMIC geography will play no small part in the readjustments effected by the peace conference shortly to sit in Versaille. President Wilson was accompanied to Europe by a staff of experts on economic geography and it may be safely predicted that both the Allied and Teutonic representatives at the conference will attend similiarly supported. In the discussions which will as a result inevitably occur, due stress will undoubtedly be laid on the part possession or ready access to raw materials essential to the maintenance of the basic chemical industries of the various nations involved wlil play in preserving the future peace of the world.

Germany early saw the national and international importance of applied chemical knowledge and her reluctance to give up Alsace-Lorraine was no doubt due to some extent to the fact that "the lost provinces" contained undeveloped potash deposits equal in richness to that of the famous Strassfurt mines in Central Prussia. The frenzied attempts made by the Imperial Government before the revolution to retain its hold on Belgium and Northern France were no doubt actuated by a similar appreciation of the chemical and industrial possibilities of the two regions.

The Lorraine district annexed in 1871 and now in the possession of the Allies contains an iron reserve of about 1,800,000 tons and yielded according to German figures about three-quarters of the total steel output of the German Empire. The adjacent French territory until the declaration of the armistice in German hands contained an ore reserve of about 3,000,000 tons of richer ore.

The potash deposits of Alsace-Lorraine produced about one-tenth of the total potash output of the German Empire in pre-war days.

When Germany is deprived of Alsace-Lorraine she will be shorn of two of her most powerful means of disturbing the future peace of the world, the source of her iron and steel industry and her potash monopoly. The importance of her retention of nine-tenths of potash resources will be considerably minimized by the fact that practically all the Allied nations have since the outbreak of the war managed to find other sources of potash more or less adequate. What the United States has done in this direction is well known and, judging from reports emanating from the British and French capitals, both oountries look forward in the not far distant future to a potash supply originating in their own dominions.

TOO much stress cannot be laid upon the importance of the point emphasized by Mr. Burwell S. Cutler, chief of the Bureau of Foreign and Domestic Commerce, in his recent speech before the American Association of Speciality Manufacturers. The war, Mr. Cutler pointed out, had taught the American manufacturer the need for scientific accuracy; he hoped that this appreciation of the value of applied science would be applied to the conduct of their peaceful occupations.

To say that the United States has come from the conflict with fewer scars than the other allied nations is to utter a truism that it is obvious to those who are at all acquainted with the conditions in Europe. But while this fortunate condition of affairs is quite widely appreciated the economic results of this condition are not. The industrial organizations of not only the Allied nations but of the members of the Teutonic confederation as well, in the course of the life and death struggle which resulted in the eventual collapse of the latter, were subjected to a conditioning process, if the phrase may be used, which was only beginning to affect the American industrial fabric when the armistice was declared.

The fourth annual meeting of the Technical Association of the Pulp and Paper Industry will be held in connection with the annual meeting of the American Paper and Pulp Association, February 3 to 6, 1919.

To Protect Dye Industry

Dr. F. W. Taussig Says Tariff Commission Will Shortly Introduce Bill

DR. F. W. TAUSSIG, Chairman of the United States Tariff Commission, in an address delivered before a meeting of the American Dyestuff Manufacturers' Association, on December 6, gave notice that it is the intention of the Commission to introduce a bill into Congress, aiming to give the American dyestuff industry a greater degree of protection against foreign dyestuff manufacturers.

"The Tariff Commission has given prolonged and careful attention to the dyestuff problem," said Dr Taussig. "It has secured a thoroughly competent expert staff of its own. It has conferred in the most painstaking way with the officials of the Administration, with the representatives of the customs division of the Treasury, with consumers and with manufacturers. It has proposed and elaborated a bill that conforms to the conditions which I have just indicated. That bill endeavors to make effective the policy adopted in 1916, and also to show the way to some moderate extension of that policy in new directions. The legislation of 1916 was in many respects a great improvement on what preceded. But defects have already appeared, and there is beyond question occasion for amendment. Evasion of some of the salient provisions of the present law is possible, especially through the importation of intermediates which are nearly advanced to the stage of finished dyestuffs. The bill prepared by the Commission goes over the list of commodities with care, rearranges the enumeration of intermediates and finished dyes in such a manner as to prevent evasion, and removes some anomalies which clearly need attention. It raises frankly the question whether the specific duty of 5 cents which was not applied by the act of 1916 to indigo and to all indigoids, whether or not obtained from indigo, natural and synthetic alizarin, and dyes obtained from alizarin, anthracene, and carbasol, should be made applicable to these new excepted commodities. This opens a question of policy, but one which, as we may perhaps hope, will be dealt with irrespective of general party differences."

Mr. A. A. Wells, of the New Jersey Testing Laboratories, will leave shortly for the Far East on a mission connected with the investigation of the oil resources of Japan and Manchuria. Mr. Wells expects to spend a year and a half in the East in connection with this work. It is understood that this investigation is being undertaken in behalf of a Japanese syndicate, with American headquarters in New York City.

J. A. Chambers, 90 West Broadway, has been appointed New York representative of Reckitts (U. S. A.), Ltd., of Great Britain, manufacturers of starch, blueing and washing compounds.

The Bayer Company Sold

German Owned Property Bought by Sterling Products Company of Wheeling, Va.

THE entire capital stock of the Bayer Company, Inc., was sold at public auction on Dec. 12 by Alien Property Custodian A. Mitchell Palmer, in front of the office building of the company at Rensselaer, N. Y., for $5,310,000 to the Sterling Products Company, of Wheeling, W. Va. The Synthetic Patents Company, owned and controlled by the Bayer Company, and the Williams Crowell Color Co., of Providence, R. I., were included in the sale of the stock. The property is subject to a Government tax of $1,034,000.

While the sale must be approved by a special committee, of which Otto Bannard is the chairman, there is little doubt that the approval will be made, and one of the largest manufacturers of dyestuffs and chemicals will pass to American hands.

There were seven bidders, one of them Paine, Webber & Co., of Boston, offering with $5,000 of the sale price. The bidding started at $1,000,000 and went by jumps of $100,000 each to $4,000,000, when it increased at $50,000 each until $4,450,000 was reached. From that point to the finish the raises were $5,000.

The conclusion of peace will not be permitted to interfere with the conduct of the affairs of the department of the Alien Property Custodian. It is likely that after the signing of the peace treaty, legislation disposing of the proceeds of the sales will be passed by Congress.

The following sales have been announced for January and February of the coming year:

January 6—F. Ad Richter Co., New York, toys and medicines.

January 8—New Brunswick Chemical Company, New Brunswick, N. J.

January 15—Williamsburg Chemical Company, Brooklyn, N. Y.

January 15—Riedel & Co., New York, drugs and chemicals.

January 16—American Linters Company, Boston.

January 23—Tropon Works, New York, manufacturers of proprietary medicines.

January 30—Ceresit Waterproofing Company, Chicago, Ill.

February 4—Chromos Chemical Company, Jersey City, N. J.

February 5—J. P. Devine Company, Buffalo, N. Y., manufacturers of vacuum dryers.

The National Chemical Products Company announces that M. Beardsley, formerly manager of their Philadelphia office, is now in charge of their New York office, 120 Liberty street.

Lieut.-Col. Harrison, controller of the chemical warfare division of the British army, died on the sixth of November of pneumonia.

Southern Californian Industries Growing

Stimulus of War Conditions Has Served to Develop Potentialities of Western State Forty Millions Already Invested in State's Chemical Industries

By MORRIS M. RATHBUN,
Los Angeles Chamber of Commerce.

HOW many well informed industrial chemists in the United States, asked for a list of important chemical producing regions in this country, would place California on the list?

Perhaps few would be inclined to do so, but she belongs there, nevertheless.

Growth of the chemical industry in California during the last two years, due, of course, to the war, has one element in it distinctly separate from similar expansion in other sections of the country where the industry already was of formidable proportions.

In California, before the war, chemical manufacturing might be said to have been an embryo undertaking. Roughly estimating the amount of capital invested in manufacturing plants and in equipment two years ago, a conservative figure would be $8,000,000, and even allowing for smaller plants, overlooked in a general summary, hardly more than $2,000,000 could be added to the total.

Now, almost overnight, California chemical manufacturing has become a husky infant and, again conservatively, more than $40,000,000 is tied up in the industry.

California has just begun to realize what chemical manufacturing means in money value, economic importance and in national and international strategy.

In a State where 40 out of 46 crude ores are to be found in inexhaustible quantities within easy reach of unlimited, cheap power and adequate rail and water transportation, what should be a proper estimate of the possible future growth and permanence of chemical manufacturing on a huge scale?

Aluminum Deposits Also.

Beds of aluminum, found within a few miles of Los Angeles, will, it is believed, receive even greater attention after peace is signed than under war conditions. Allied industries, for the manufacture of aluminum utensils and other supplies are organized and waiting in anticipation of the great expansion expected to come with the re-establishment of normal conditions.

Desert brines, in great quantities, are producing calcium chloride—calcium chloride that tests the equivalent of any chloride produced in the East. Also, calcite and gypsum deposits of the highest quality are available for any demand.

A few others, described briefly for rapid scanning are: Lead, large quantities of ore, but virtually untouched at present; gold and silver, mined extensively throughout California; tungsten and molybdenum, important deposits in Los Angeles county; carbon, principally obtained from oil; sulphur, in large deposits near Owens Lake; copper, mined both in Northern and Southern California; manganese, adequate, apparently, to any demand; magnesium, great deposits, from which 1,000 tons are daily being shipped; epsom salts, "as good as anything produced in the East" and in large quantities. There are many others that might go on the list, such as bismuth, chromium, arsenic, zinc, antimony, boron, mercury, silica, fluorine and chlorine—and then the list is not complete.

The dye industry, always lying in wait for chemicals and for chemical by-products, is looming on the California horizon as a "war baby" that must be carefully nursed and murtured for the big industrial competition that approaches.

The Lower California Chemical Company, at San Diego, has erected units of a plant to be devoted to the manufacture of orcein dyes from the orchilla weed, a moss which grows in unlimited quantities near the coast of Lower California. For these dyes it is claimed that they are equal in every test to foreign dyes, and the cheapness of obtaining raw material and relatively low cost of manufacture are urged as additional claims of their excellence.

Manufacture of Dyes.

Using the by-products of local oil refineries and gas plants the Internal Dye Products Company, of Southern California, has equipped a plant near Los Angeles for the manufacture on a large scale of aniline dyes.

The largest output of the citric acid in the United States now comes from California. And here the famed citrus industry of the State appears in a new role. Millions of lemons, known to the trade as culls, are being utilized in citric acid production. The W. J. Busch Company, with headquarters in England, and with large interests in the lemon growing districts of Italy and Sicily, is one of the large firms now permanently located in California for the manufacture of citric and other acids.

Grouped about the Searles Lake deposits of Sodium and potassium salts, the Solvay Process Company, the American Trona Corporation, the Pacific Borax Company, and smaller enterprises, are manufacturing large quantities of the various salts available from the unlimited deposits. New units of existing plants, calling for the expenditure of millions of dollars, are in process of construction.

Emboldened, it may be, by the profitable past and the present successes, California's manufacturing chemists are seeking to assure a bright future by adding one more great crude to their credit—nitrate. It is whispered, literally that, that chemists already have located likely beds of nitrate mud. Should the reports prove true, and nitrate should be found in sufficiently large quantities, only the transportation problem will stand in the way of either an elimination of the Chilean importations or in a decided adjustment downward in the cost of the Chilean nitrate with the coming of competition from California.

Capital, always coy with strangers and new undertakings, has broken no precedents in its attitude toward the growing, but nevertheless continuously struggling, chemical interests in California. Some developments seemed almost too good to be true, others looked uncertain or visionary, but, on the whole, supply of capital and potential chemical manufacturing development in California are approaching a more even basis.

Many local California enterprises, the stock raisers, the orange growers, to a certain extent the oil interests, are looking more favorably upon the chemical industry as good soil for investment.

Growth is a slow process, but any Californian, whether he be a native or a resident of only a week's adoption, will tell you, and come rather close to convincing you, that anything started in California is bound to be finished not only with success, but with greater success than could be found in any other section of the globe.

Perhaps it would be difficult for many to agree with the optimistic prophecy of C. W. Hill, pioneer chemist and manufacturer of Los Angeles, who sees California as "the possible future location of the largest chemical producing activity of the world."

Rich in Resources.

Of the 40 odd crudes or elements found in California, 28 are being manufactured in the State itself and about 12 are being sent to the East for refining. An elementary study of freight rates and refining costs can convincingly demonstrate that California refineries are the cheapest and, therefore, the logical solution of the production problem.

Now, the very obvious question arises, "Where did California find all this marvelous array of crude ores, heretofore undiscovered, undeveloped and unguessed?"

In the larger sense, by far, the answer is: The desert!

When the war came, shutting off Germany's for-many-years-taken-for-granted indispensibility in the chemical world. American chemists were forced to act, not only to insure a good, fast black in a neat, well turned silk stocking, but to step out with something not only "just as good," but better in explosives, munitions—a thousand essential things—than Germany herself had produced.

Eastern manufacturing met the situation by increasing and extending production and improving the product. California chemists waded into the problem and created an industry. Their achievements amount to nothing less than that.

Who has not seen the famous "20 mule team" and immediately identified it with California? California and borax? Outside of borax, gold and silver, and some carbonate of soda, what other chemicals have been significantly identified with California?

Under the whip of necessity, California chemical manufacturers, or, rather, potential manufacturers, sent men out into the hot, arid, unfruitful California desert and there was discovered an Aladin's garden of crude chemicals merely awaiting, in many instances, the persuading force of a surface scoop or the revealing power of a few lusty picks and shovels.

Some few went into the sea, and from the giant kelp, or seaweed, beds of the Pacific Ocean reaped a dripping, slimy harvest that later, reduced to char, made the first pretentious challenge to the German world-monopoly of the potash supply.

Potash Industry Growing.

This kelp-potash industry on the Pacific Coast is a permanent activity. The giant kelp beds are renewed within from two to four months after the elaborate kelp-cutting devices, mounted in many cases on self-propelled barges, reap their harvest. The federal government has under consideration comprehensive transplanting of the Pacific kelp in Atlantic waters.

And the kelp interests are beginning to branch out and ramify. Iodine from kelp is a proven success, and quantities of dyes, and a certain kind of glue, which, under special test, "tore the surface off of glass," are being manufactured from the sea growth.

Of course, there is Searles Lake, with all that the name implies and signifies. One of the first big desert "finds" proved to be strontium, heretofore imported almost exclusively from England and Germany. Three extensive deposits of strontium sulphate, and of deposit of strontium carbonate, were discovered within easy distance of Los Angeles.

Immediate result: Two local plants erected, equipped and in full swing for the manufacture of nitrate from carbonate, and a string of freight cars speeding along to deliver the crudes to Eastern chemical manufacturers.

Then, Mr. Thomas A. Edison, who uses so much of it in his batteries, was not the only person in the United States who welcomed the news that lithium, in large quantities, had been found near San Diego. It is claimed that these San Diego deposits are virtually supplying the entire demand for lithium in the United States at the present time.

Discovery of large nickel deposits, said to rival the famous Sudbury deposits in Canada, has been made near Los Angeles and California manufacturers already have succeeded in interesting Eastern and Middle Western capital in the prospects.

While large bodies of iron pyrites have been found in Riverside county, lack of an adequate supply of fuel, coal, in this instance, has postponed for a time working of the ore in large quantities.

Business Men Must Be More Scientific

Chief of Bureau of Foreign and Domestic Commerce Wants War-Time Precision to Be Carried Over Into Peace-Time Methods—Should Be No More "Hunches" in Business.

A TELLING plea for scientific accuracy in commerce and industry was made by Burwell S. Cutler, chief of the Bureau of Foreign and Domestic Commerce, speaking before the convention of speciality manufacturers at Cleveland, on November 21. The war had taught American manufacturers the basic necessity of scientific precision, Mr. Cutler acknowledged, but there was, he claimed, still much room for improvement. While under the pressure of war time needs, American manufacturers and business men had placed their affairs under the supervision of the best scientific brains to be found in the country, this same attitude towards scientific methods should not be permitted to pass with the coming of peace.

"Doing business 'on a hunch' from now on will entail overhead costs that spell annihilation for the producer or merchant who must meet severe competition," said Mr. Cutler.

"No longer can we depend upon the very easy conditions which have heretofore covered up our mistakes. In the early days of this country our tremendous natural resources on the very surface of the land and an endless chain of immigation, providing labor and customers, produced in combination a market from ocean to ocean and from semitropical Mexico to the Arctic region that would absorb almost any product fairly attractive. Excessive overhead costs, due to lavish use of men, materials and time, were easily covered in prices which could not be resisted in all localities; that is, enough purchasing public might be found here or there to keep us going, regardless of lower prices from competition. Distances in the country created transportation costs in many cases so high that they over-shadowed the difference in price between an article highly priced from one producer and the same article at a more reasonable price from another quarter. We had not yet reached the European stage of intensive production and marketing amongst crowded cities within easy range of one another.

Need of Co-operation

"Things are different now. Our industrial capacity in many directions exceeds the normal demand. A sign of this is found in the widespread concentration of trade individuals into association for the purpose of eliminating self-destructive competition on the part of those units who do not respect actual costs and the necessity of trade integrity. By mutual enlightenment they hope to banish ignorance and market treachery. Another sign of over capacity is the attraction to overseas trade that is operating on every hand.

"Likewise, we have seen many a business concern dashed on the rocks of its own temerity. The appalling percentage of business failures in the United States is due very largely to ignorance: ignorance of cost accounting, ignorance of market, ignorance of proper production methods and ignorance of the human element composing labor. As a nation we have generally depended on luck and hustle to produce the big results of which we are so fond. Evolution, stability and a long look into the future have appeared to us somewhat superfluous to success on a big scale. We have been looking fondly at the size of the superstructure and have paid little attention to the foundation. I do not attribute this attitude to all American enterprises, for I must except some concerns of national scope whose foundations are laid solidly in the concrete of study, experimentation and laboratory research. And yet the early history of many of them shows instances of deplorable losses through neglect of facts that should have been ascertained before certain markets and market methods and financial outlays were undertaken.

European Competition

"Outside of our own boundaries we are more certain than ever to meet the competition of merchants who know thoroughly what they are doing. The European merchant is a grubber after facts. He studies his field like a jewel appraiser with his microscope, like a professional taster of teas with a sensitive mouth, like a lace buyer with his millimeter rule. His banks go carefully and patiently into the personal life of a possible customer; his official advisers take into account even the political views of a consignee and his utilization of racial preferences for color, style, size, etc., is infinite. His habit of action is still that of a painstaking artisan who slowly fashions a commodity and then carries it from household door to door, inquiring about the health of the family while his commodity undergoes pitiless inspection upside and downside by the entire household. He does business minutely on a large scale.

"So indeed do many of our largest concerns, after they have reached the point of size where laboratories and a scientific staff can be afforded. In organizations of that scope, incidental or overhead expenses run into such high figures that savings, small in point of percentage of total output, are large enough to justify elaborate methods of economy; it is noticeable that success in competition with European producers and merchants has been confined principally to concerns which could afford the refinements of cost control. That is one reason why I cannot condemn aggregations of capital and labor under a signal organization. Against the possibility of their superior strength being used to throttle competition and to fix extortionate prices—an offense that is seldom committed— I credit them with power of employment and livelihood to the greatest number of people. The resources and the men involved turn out many more units of production than would emanate from an equal amount of men and resources in the control of many separate individuals. Trade associations are born with the same instinct to join forces, not in a scheme of piracy but for human and economic salvage. By far the best educated producers that I know are those who have studied their problems in association. In Europe today unified policy and action have become an obligation forced upon the trades by the several Governments.

"What I mean by commercial education is not a conglomerate of knowledge about trade in one man's hand. The acquisition and retention of too much data can easily sap the creative energy necessary to forward vision and progress. I do insist, however, on the analytical habit of mind that demands the basic facts of a business proposition. I would have the manufacturer of woolen clothing know something of wool from the point of its original source to its transformation into textiles; a manufacturer of buttons ought to know the entire history of vegetable ivory, galilith and like substances; the cotton textile merchant should carefully watch crop movements, prices, sales, etc.—all to the end of buying and selling at the right time. One cannot over-emphasize the advantage of being in point of information ahead of current conditions."

Plant's Fate Not Settled

The final fate of the big explosives plant at Nitro, sixteen miles from Charleston, N. C., is yet undecided. The Thompson Starrett Company, construction agents for the War Department, have filed an application for abandonment of contract. Five of the units of the plant have been completed and work on the other two units has been stopped. Work on these two latter units is being, however, to protect machinery, etc., when a shutdown does take place.

At the third annual meeting of the National Wood Chemical Association, the following officers were elected: W. L. Saunders, Cadillac, Mich., president; John Troy, Olean, N. Y., vice-president; F. J. Goodfellow, Bradford, Pa., secretary-treasurer.

Importation of crude saltpeter during the eight months ended with August amounted to 4,900,032 pounds, against 7,529,180 pounds in the same time last year and 9,258,084 pounds in the corresponding period two years ago.

Lignite Experts Tour U. S.

Canadian Scientists Engaged in Survey of Lignite Resources.

TWO Canadian scientists, representing the recently formed Lignite Utilization Board of Canada are now touring the United States on a mission primarily concerned with an inspection of the lignite resources of the United States. After spending a week in New York City, they went to Washington and thence to the various leading centres in the Pennsylvania coal district. It is their intention to travel through to the Pacific coast. Early in the New Year they will return to Montreal, the eastern headquarters of the Lignite Board, after making inspections of the various coal and lignite districts of the Canadian West.

The Lignite Board of Canada is a subsidiary of the Advisory Council of Research of Canada, organized early in the war by the Canadian Government. For two years past the Council has been doing a great deal of work in the direction of making more intensive and economical use of the Dominion's resources and it is in line with the further development of this policy that the two scientists are touring the United States.

The coal problem of Canada since the United States entered the war has been very acute. The obvious need for a domestic source of supply has drawn the Government's attention most forcibly to the need of making use of the large supplies of low grade coal available in the Canadian West.

At present Western manufacturers both American and Canadian prefer to use the American bituminous coal, in spite of the high prices rather than make use of the Alberta and Sasketchewan lignite.

Canadian scientists believe that the low grade coals of the West can be made commercially valuable and to study ways and means of bringing this about the Lignite Utilization Board was formed.

The coal deposits of Saskatchewan furnish coal of the lignite variety only. As some of the physical qualities of this coal prevent its economical and efficient commercial use, the yearly production has so far been small. This despite the fact that a rapid increase in population has increased the fuel demands of this part of the West very considerably.

The production of Lignite in 1915 from thirty-three Saskatchewan collieries was 240,107 tons; in 1914 the production was 232,299 tons. From figures at present available the production this year will be slightly larger than it was last year.

The production in Alberta in 1915 was 1,682,922 tons. During the first eight months of the current year it was 1,781,235 tons.

Some Processes of Rubber Manufacturing

he Preparation and Mixing of Various Compounds—The Reclamation of Rubber—Manufacture of Rubber Substitutes—The Process of Manufacturing Automobile Tires.

By FREDERICK J. MAYWALD, F. C. S.

THE rubber manufacturer uses many other materials besides crude rubber. He uses first of all mineral fillers of various kinds such as niting, white lead, litharge, or sublimed white lead, ide of zinc, asbestine, various coloring substances, ch as iron oxide, ultramarine blue, lampblack, etc., fteners such as vaseline, palm oil, tars, etc., and bstitutes, so called, which are not at all substi-tes, but are simply fillers or cheapeners and are ade by treating oil, either vegetable or mineral, ith sulphur chloride, which produces white sub-itutes; or boiling the oil with sulphur, which pro-ices the brown or black substitute.

Then there are large quantities of reclaimed rub-rs or shoddies used. These shoddies are prepared om about every variety of rubber known. If one preparing a shoddy from tires, the bead is re-oved first of all, the rest of the tire is then ground a crushed mass with proper corrugated rolls and is crushed mass is then placed in large boilers (in ie alkali process) and boiled up for a long time ith a solution of caustic soda, under pressure and relatively high temperatures. This treatment de-roys the cotton fibre and removes some of the free unvulcanized sulphur, some of the fillers such as nc oxide, some of the lead, etc. After the boiling ocess is complete, the rubber is blown out of ie cooker, the liquor contained in it is drained vay, the rubber washed, dried and finally "sheeted it." After sheeting out the rubber is run through hat is known as a refiner. This consists of two illers which can be set very close together so that e rubber comes out from between them, with a iickness of about one five-thousandth of an inch. his thin sheet is then passed under a heavy iron ir, known as a "doctor," which is a sort of a raper. This scraper removes any unaltered rub-r from the sheet. These thin sheets of rubber are ien rolled up and the rubber, being still warm and astic, soon packs into a solid mass.

The Acid Reclamation Process

In the acid process of reclaiming, the rubber is eated with a dilute solution of sulphuric acid, ashed and finally goes through the same process s the alkali reclaimed rubber. These are the two rincipal processes. There are some small amounts f rubber prepared by the old mechanical process, which the rubber stock is ground to a fine powder, he cotton being blown out by compressed air. Very ttle of this type of reclaimed rubber is made to-ay, the larger portion of the reclaimed rubber be-ng prepared by the alkali process. There are, in eality, forty grades of reclaimed rubber or rather of raw stocks from which reclaimed rubbers are made, sold in the market.

Where a rubber compound has to be soft enough to be driven through a fabric, as in the preparation of tire fabric, there is added to the Hevea or other high grade rubber a softer rubber such as Pontianak, Accra Flake, etc. A rubber compound is built up along definite lines, having always in mind the purpose for which the finished product is to be used. If we had to build an inner tube, we would take a high grade rubber, such as smoked sheet, add to it a certain amount of zinc oxide, some whiting and sulphur; if a red tube were wanted we would use antimony sulphide, either golden or crimson, or a mixture of the two, depending upon the color desired. If we were building a gray tire we would use the same rubber but would use a filler of litharge, whiting and possibly some zinc oxide. For a tire tread, we would use a plantation rubber such as a smoked sheet, add a certain amount of a softer rubber, such as Caucho ball and use for the filler principally zinc oxide together with smaller amounts of whiting, aluminum flake or similar filling material and sulphur. If on the other hand we were going to produce a cheap stock, such as moulded hose or packing, we would probably use very little if any new rubber, depending chiefly upon reclaimed rubber, adding to it whiting, a softener such as vaseline, sulphur, perhaps oxide of zinc, litharge, magnesia and other fillers, the nature and amount of these fillers depending upon the article to be manufactured. If the manufacturer wishes to produce a hose to withstand acid, we could of course use none of the fillers soluble in acid, such as zinc, whiting and whiting but would use in place of it flaked silica, or tripoli. If we wanted a softer rubber for frictioning, as for building the carcass of a tire, we would use a plantation rubber of one of the softer grades, add to it a certain amount of Pontanak or possibly Accra Flake and a small amount of filler, usually zinc, or possibly whiting and sulphur. These would give us certain definite products, with certain specific working qualities, ageing qualities and what might be called "life tests." For instance, a man might build a tire tread from nothing but Para rubber and zinc oxide and obtain a tire which was very tough and hard but which would not have the wearing qualities of the same tire if built from softer rubber or partly with a softer rubber. He would not get the wearing quality from a tread stock containing nothing but rubber and sulphur that he would get from a tire compound in the way in which I have described.

The Manufacturing Process.

In making rubber goods, whatever the compound nay be, it is weighed out in the compounding room nd the batch, as it is called, is sent to the mill. The nill consists of two heavy rolls, revolving toward ach other at different speeds. For instance, in a ertain sized mill, these rolls might revolve at 12 nd 16 revolutions a minute. In a model plant vhich I have set up in my laboratory there are two uch machines, one with two rolls, the other with hree. In the two roll mill, the rolls are set horiontally against each other, while in the three roll nill, the rolls are set one above the other. The hree roll mill is what is known in the rubber trade s a calendar. The rolls in both the mill and the alendar are hollow and each roll is fed by two ets of pipes, one set for cold water, the other for team. Your mill man uses either as necessity rises. The grinding of rubber in one of these mills reates considerable heat, due to the friction, and as n excess of heat will destroy the rubber and after he sulphur has been added may even cause the ubber to vulcanize on the rolls, it is necessary vhen the rubber reaches a certain temperature to urn on the cold water. The mill man may at the tart warm his rolls by allowing a small amount of team to go into them but in many mills it is the ustom to dispense entirely with steam lines on the olls.

The Making of the Stock.

In making up his compound the mill man first hrows onto the rolls of the mill the rubber. This s ground down until it is soft and plastic. The dry llers are then worked. The plastic rubber takes ese fillers up readily and the excess which falls etween the rolls is caught in a pan below. From his pan the material is collected and returned to the olls.

During the milling operation the rubber is frenently cut from the rolls, to allow it to cool on he under side This also improves the "mix." Vhen all the compounding ingredients are mixed in, he stock is cut from the roll and rolled up. It is hen once more run through the mill in sheet form. his operation is repeated until a thoroughly uniorm product is obtained. From the mill the stock sually goes to the cooling room, where it is allowed cool off and to recover its "nerve."

If the manufacturer wishes to turn out tires or re treads, the rubber is once more warmed up and nade somewhat plastic on the mill and then run rough the calender to be made into sheets. For e sheeting process these rolls run at the same eed and a series of knives is fitted to the front of e calender. These knives cut through the stock d are set at fixed distances apart, so that the ck removed from the calendar will be cut into e right lengths for its immediate use The stock fed on to the calender from time to time and the calendered stock is run out between sheets of unbleached cotton. It is possible of courst to set the calender rolls to any gauge or thickness that is wanted. Tube stocks are usually calendered at 1-64 or 1-32 of an inch.

The Making of Tire Treads.

A tire tread is built up in step formation, with five or six or even seven layers, each layer being narrower than the one beneath it. If frictioning is to be done, that is if tire ducks are to be used, the calender is set with two sets of gears and the keys are removed from the set of gears that run at even speed to the opposite end which produces variable speed of the different rolls. This gives a driving or grinding action and forces the rubber into the fabric. The stock in every case is worked between the middle and the lower roll. In the case of frictioning, the cotton fabric is run between the lower and the middle roll and the rubber stock adherent to the middle roll is driven into the pores of the fabric. Later on a skim coat, as it is called, may be put on top. This frictioned stock is then taken away and cut to the required width and length. In tire fabrics, hose, etc., the stock is usually cut on the bias.

If a moulded hose or tubes of various sorts are to be produced, the stock is taken from the mill and put through a tubing machine. This machine is built to force the rubber out of a given sized die. If a tube is required, the die has a centre core, around which the rubber must flow. Thus in a moulded hose the central tube is first produced from a tubing machine. It is then semi-cured, as it is called, in other words, partly cured or vulcanized. This cured tube is once more run through the tubing machine and a thin coat of unvulcanized rubber put over it. The coated tube then goes to the braider, where the layer of cotton is braided on to it. After this the tube is again run through the tubing machine and another coating of unvulcanized rubber applied. Another layer of braiding is laid on and finally the outer layer of rubber applied. The hose is then cut into long lengths, placed in molds and cured.

Rubberizing of Fabrics.

In the production of rubberized fabrics, such as raincoats, the rubber compound is placed in a churn or mixer, a certain amount of gasoline added and the whole run into a thick dough of uniform composition. This dough is then applied to the cotton fabric on what are known as spreaders. The cloth passes under a knife called a "doctor" which is so set as to permit a certain amount of the rubber dough to be deposited on the cloth. The cloth is then conducted over a steam table where the solvent is driven out.

Many other types of goods are produced in special ways. Surgical goods, such as transparent

Notes on the Occlusion of Gases in Metals

English Scientist Before Faraday Society Discusses Some Phases of Reactions Between Gases and Metals.

By ALFRED W. PORTER, D.Sc., F.R.S. *

IN 1817 Humphrey Davy noticed that combination could be induced between various gaseous mixtures when brought into contact with platinum foil or wire heated to a temperature "short of redness." Döbereiner (1822) showed that spongy platinum induces combination between hydrogen and oxygen t ordinary temperatures. Other solid substances possess the same power, though to a less degree. Fluorspar, marble, and mercury did not exert any perceptible action even when heated up to the boiling-oint of mercury. Faraday explained the action as due to a condensed layer of the gases on the sur-ace of the solid. Platinum, palladium, and carbon all possess the power of absorbing (or adsorbing) arge quantities of gas. The name "occlusion" was given by Thomas Graham to the property of ab-orbing hydrogen at a red heat and of retaining that gas at a temperature under redness for an indefinite ime. The occlusion of hydrogen was most marked in the case of palladium even at low temperatures. The palladium was exposed to hydrogen between 90° and 97°C. for three hours and then allowed to ool in the gas for one hour and a half. When heated by a gas flame and pumped off, the metal yielded 43.3 times its own volume of hydrogen.

The name "occlusion" probably covers a number of different phenomena which take place either singly or in conjunction. These can be enumerated under heads. Firstly, chemical combination of gas with metal; e.g., hydrogen with sodium, potassium, or palladium to form Na_2H, K_2H, Pd_2H (Troost et Hautefeuille) or PdH (Graham). Secondly, simple solid solution, either separately or in conjunction with the above; e.g., when hydrogen is occluded by lithium (T. and H.). Thirdly, solid solution; e.g., hydrogen in palladium (Roozeboom and Hoitsema). Fourthly, solution accompanied by surface adsorption. Fifthly, surface condensation under molecular forces (unaccompanied by solution); especially in pores formed by the condensing material. Sixthly, inclusion, as when bubbles, large or minute, become entangled in the molten viscous mass and cannot escape from it.

It is usually a delicate matter to distinguish between these various types in practice; and in any case the discrimination requires a very detailed examination of the phenomena.

The matter can be well illustrated by the case of the occlusion of palladium in hydrogen, which has been extensively investigated.

Graham concluded from the change of density of palladium when it occludes hydrogen that a chemical compound PdH is formed. Troost and Hautefeuille conclude from the constancy of the disassociation pressure as soon as the volume of hydrogen is no longer more than 600 volumes that the compound formed is Pd_2H.

On the other hand Hoitsema disputes the validity of this conclusion resting his objections on experiments by Roozeboom and himself.

Hoitsema applies the distribution law of van't Hoff and Nernst to these immiscible phases and concludes than when under small external pressure hydrogen occludes as monatomic molecules; but that if the volume of 2 mgr. of condensed gas is less than 0.8 c.c. (at temperatures between 150°C. and 200°C.) the condensed molecules are diatomic.

At higher temperatures the results are more complicated and have not been interpreted in detail. In all cases there is some uncertainty about the estimation of the concentration of the hydrogen in the metal, since it is not known whether (or not) it is uniformly distributed within it.

If the slope of the curves in the region of mixed phases is not insisted upon, comparison might be made with the behaviour of a liquefying gas, as in Andrew's diagram, with an apparent indication of a critical point at some temperature higher than 200°C. The two phases might then be liquid hydrogen and gaseous hydrogen; the volume of 2 mgr. being respectively about 1 and 4 c.c. at 140°C. The phenomenon would then lie in the fourth or fifth of the above groups; more probably the latter.

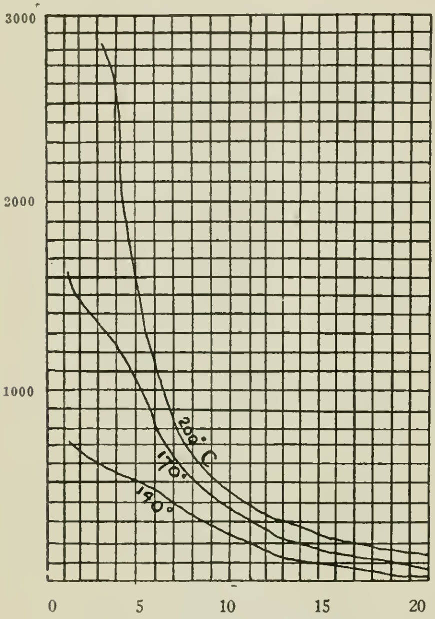
It has been objected to the condensation theory that the heat set free is far in excess of the latent heat of vaporization of the gas.

Holt, Edgar, and Firth conclude from their own investigations that hydrogen is occluded in palladium in two ways: (i) in an absorbed layer of high vapour pressure which can easily be removed by evacuation; (ii) as an absorbed gas which is non-uniformly distributed within the body of the metal. As the temperature rises the pressure of the absorbed gas increases, whilst the adsorbed layer diminishes, so that the approximately horizontal part of the curve (such as Hoitsema's) will become shorter, until at about 300°C., where the difference between the pressures of the adsorbed and absorbed portions is negligible, the curve will approximate to a straight line.

---

* *Read before the Faraday Society, November 12, 1918.*

Sieverts ‡ has extended measurements up to the melting-point of palladium (1,550°C.), and finds that on liquefaction the occlusion rapidly falls off to about half value.



Volume (in c.c.) of 2 mgr. Hydrogen when occluded in Palladium. (C. Hoitsema.)

Wolf § measures the electrical conductivity of palladium and decides as follows:—

(a) The conductivity diminishes proportionally to the occluded quantity of hydrogen as long as the hydrogen is being merely dissolved.

(b) It diminishes asymptotically as long as a chemical combination Pd_2H is being formed; i.e, from an occlusion of 40-600 volumes gas to unit volume of palladium.

(c) After this range further hydrogen dissolves in Pd_2H and the conductivity again diminishes proportionally to the additional quantity occluded.

Holt ‖ concludes that the time-rate of solution of hydrogen by palladium is not a simple function of the concentration of the gas. The rate curves consist of two portions (except in the case of palladium black), which are interpreted as referring to solution in two different forms of the metal. The smooth curve obtained for palladium black is taken to mean almost complete absence of one of these forms.

For example, the heat set free in the occlusion of 1 gram hydrogen in palladium is about 4.672 cal (Mond, Ramsay, and Shields). For the occlusion in platinum the value is 6.610 cal (M., R., Sh.). On the view that the hydrogen is liquefied in the pores it has been thought that these values ought to be identical. The heat of vaporization of hydrogen at −252.8°C. is 123 calories per gram (Dewar, 1905). It must be remembered, however, that the heat of vaporization from the surface of a solid may be expected to be much greater than from the liquid hydrogen itself. By Dupré's formula the value of the latent heat per unit-volume of liquid is equal to the value of the intrinsic pressume due to molecular attractions. These attractions between platinum and liquid are certainly much greater than between two layers of liquid hydrogen. This must be so, if for no other reason, because condensation of the gas would not otherwise occur at a temperature many times its usual critical temperature. For the same reason the heats of occlusion in pores of platinum and of palladium will not be identical. For if the pores are large enough no condensation will occur; while if their diameters are within the molecular range of the metals the specific character of these metals must have an influence.

The difference between the fourth and fifth groups is that the term adsorption should probably be restricted to the case in which true solution takes place, but in which there is a modification (either increase or decrease) of the concentration in the surface firm arising from the influence of the dissolved body upon the surface tension. This is quite distinguishable from the case of surface condensation without solution; although both are due to molecular attractions.

Sieverts * finds that iron begins to occlude hydrogen at a temperature of about 400°C., from which point it increases according to an almost linear law up to 850°; at 850°C. there is a break in the temperature concentration curve, the concentration showing a rapid increase up to 900°, after which the concentration again becomes linear up to the melting-point, when the concentration rapidly diminishes.

Amongst phenomena due to absorption of gases in iron may be mentioned the passivity of iron † and the embrittling of iron by caustic soda.‡ With regard to metals in general, the Volta effect has been often attributed to condensed gases; and in J. Brown's experiments it vanished entirely when these films were removed by boiling in linseed oil. Much modern work on this subject is being done by O. W. Richardson, H. A. Wilson, Soddy, Just and Haber, Fredenhagen, Pring, Langmuir, and many others. H. A. Wilson found that the electron emission from platinum at high temperatures was decreased to 1/250,000 of its former value by a preliminary heating of the platinum in oxygen or by boiling in nitric acid. The admission of a little hydrogen brought the current back to its former value. Soddy § found that the currents obtainable from a Wehnelt cathode stopped suddenly if the residual gases on the vacuum tube were absorbed

(*Concluded on page* 509)

Abstracts of Current Magazine Articles

British Control of Acid Industry—The Manufacture of Artificial Silk—Chemicals from Seaweeds—Paper Yarn Industry in Europe—The War's Effect on Supply of Photographic Chemicals.

Acid and Fertilizer Industry.

British Control of Acid and Fertilizer Industry —Board of Trade Journal—London, England.

One of the most complete controls exercised by any department of the British Government during the war, was that exercised over the acid industry and fertilizer connected with it. The control was continuous and unbroken from the mining and shipment of the raw material down to the delivery to the consumers of the finished products.

The key industry, the manufacture of sulphuric acid, was first controlled through the control and distribution of iron pyrites, imported chiefly from Spain and Norway, the principal raw material upon which the sulphuric acid industry depends. The pyrites were controlled at all stages, prices were fixed and rationing inaugurated.

Numerous economies resulted from the completeness of control exercised by the Government. Use was found for a number of industrial by-products hitherto wasted. Niter cake was introduced into 25 trades where sulphuric acid had hitherto performed a somewhat crude function, as in the textile and dyeing trades, grease recovery and metal picking.

Another important economy was effected by the utilization of pyrites residues under centralized control. Steps were taken to work up the noncupreous residues from iron pyrites, after the sulphur had been removed at the acid works, in order to make them suitable for the manufacture of iron in the blast furnaces.

Artificial Silk, The Manufacture of

Our Increased Manufacture of Artificial Silk—The National City Bank, New York City.

The United States after being an importer of artificial silk is today one of the world's largest producers and exporters. The exportation of artificial silk stockings from the United States has reached over six million pairs.

In describing the process of manufacturing artificial silk, says this article, wood pulp is treated in most cases with caustic soda to form a sodium cellulose and is then dissolved in carbon disulphide. The product alkali-cellulose-xanthate is popularly known as viscose. After being filtered and allowed to ripen by standing, it is forced through minute holes into a liquid which solidifies the threads.

Silk goods made from this artifical fibre are chiefly remarkable for their brilliancy but have a somewhat harsher "feel." Some of the early shortcomings of the early product are being gradually overcome .

Chemicals from Seaweed

Solvents from Kelp—an Infant Industry—C. A. Higgins—American Industries—Oct. 18, 1918.

The Hercules Powder Company in an effort to alleviate the world side shortage of potash established an experimental plant near Los Angeles, Cal., to extract potash from the kelp which grows so luxuriantly along this part of the Pacific coast. The company expected that a number of other chemical by products of the process would be found commercially valuable.

The venture has already developed for the first time on a commercial scale a whole line of chemical products.

The Hercules process of producing solvents and their intermediates from kelp is, according to this writer, very simple. After being harvested and brought to shore the kelp is macerated, pumped into tanks, diluted and allowed to ferment at about ninety degrees F. after finely ground limestone has been added to neutralize the acid produced during the process of fermentation. After the lapse of fifteen days the leafy structure of the kelp is entirely destroyed and a liquor obtained which contains acetate of lime, muriate of potash, and iodides in solution. The crude salts obtained therefrom are heated in retorts to obtain acetone and the muriate of potash obtained by leaching and crystallization.

The Hercules process is productive of not only acetate salts but of propionates, butyrates, valerianates and even of the higher acids of this series. It is this series of salts which by conversion into their ethyl esters is providing the trade with an entirely new series of amyl acetate substitutes in the ethyl propionate, ethyl butyrate series.

Ethyl acetate is a well known product. It is used as a solvent of nitrocellulose in the manufacture of artificial leather, in finishing celluloid and in a great many other well known ways. Ethyl propionate and ethyl butyrate are excellent solvents of nitrocellulose, resins and gums. Ethyl propionate boils at 100 degrees C. and appears to resemble in its properties a mixture of ethyl acetate with about ten to twenty percent. amyl acetate. Ethyl butyrate boils at 120 degrees C. and resembles amyl acetate very closely in its physical qualities. These two esters it is believed will find a wide field of usefulness in the soluble cotton, artificial leather, paint and varnish trades.

Special mention is made in this article of the valerates, caproates, etc. Valerain and its salts and esters is well known in the drug and pharmaceutical trade and it seems likely that new sources will be welcomed by the trade. The esters of these acids will be sought after by the essense and perfume trades.

Paper Yarn Industry, The German

The Paper Yarn Industry in Germany—Frankfurter Zeitung, Sept. 20, 1918—Commerce Reports.

This industry has expanded to such an extent since the outbreak of the war that according to the writer of this article about 88,000,000 tons of yarn are today being produced.

The manufacturing processes are constantly being improved and as matters now stand, paper yarn can be used in the manufacture of various fabrics and garments, excepting only body linen and the better sorts of outer clothing. Workingmen's clothes, bed and table linen, curtains, sail cloth, imitation leather are all being successfully made.

German Textile Substitutes—Research Department, Bureau of Foreign and Domestic Commerce.

According to the report the third German Fiber Exposition was held in Leipzig late in August. While according to reports published in German newspapers, regarding these expositions, a great variety of products were shown, there is evident in Germany in spite of the efforts of the manufacturers to counteract it, considerable skepticism regarding the possibility of paper textiles serving as entirely satisfactory substitutes for cotton and wool.

The principal exhibit at the Leipzig show, was that of the Textilose Werke und Kunstweberei Claviez Akt.-Ges. of Adorpf, Saxony.

Besides clothes of textilose and cellulon, the products of various fibre plants such as the cat tail, some truf plants, the cotton grass and the broom were shown.

Photographic Supplies, War's Effect on.

Eastman Kodak Confident of the Future.—B. L. B. Jones—Printers Ink, Nov. 21, p. 41.

American manufacturers of photographic materials have risen to the situation in their industry caused by the outbreak of the war in Europe. Before the war, not only a large proportion of the lenses used in American cameras came from Europe, but nearly all the developers and the raw photographic paper. Today the only problem before the American lens makers is the question of quantity production. American anastigmat lens are the equal of any in the world. So far as photographic paper is concerned, a new mill almost completed, will shortly place the Eastman Company in a position of independence so far as foreign sources of supply are concerned.

According to the writer of this article the war has also taught photographers economy. In prewar days tons of discarded negatives could be found in the cellar of any long established photographer. Today instead of laying these negatives aside, emulsion is washed from the plates, silver recover from the emulsion, the glass recoated and sent again as dry plates.

Must Protect Dye Industry

Dr. J. M. Matthews Claims Government Aid Necessary

Speaking before the Philadelphia section of th American Chemical Society, on November 21. Dr J. M. Matthews, consulting chemist of this city, de clared that it had been impossible for the Americ dyestuff industry to build along permanent line under war pressure. He contended that with th restoration of normal conditions, a great amount plant equipment would have to be scrapped.

"In the approaching period of reconstructio said Dr. Matthews, "the dyestuff industry mu have room to turn around in, so that it can wit stand the normal agencies of competition In present shape, built up as it is in a more or l temporary way, if it is suddenly confronted with destructive force of unrestrained and unlimited Ge man competition, the dyestuff industry of this cou try will be faced with the danger of going down in a pile of ruins. This would be a disaster that th country cannot afford."

This situation could be avoided, Dr. Matthe claimed, by a proper policy of Government prot tion. A tariff protection of the usual kind was sufficient. Some such plan as that adopted by British Government should be tried out. Und this plan a license committee having control of imports and exports of dyestuffs should be form Such a committee should be made up of represen tives of the industries involved and the consum of dyes.

Demobilizing Chemists

Under the guidance of Major Allen Rogers, Industrial Relations Division of the Chemical W fare Service has undertaken the task of findi peaceful occupations for the thousands of chemis drafted in the chemical branch of the service si its formation.

In order to facilitate the transfer of these m from wartime work to industrial occupations, che ists are being requested to consult Major Roge in regard to their future intentions and manufa turers are being asked to let Major Rogers kn exactly what their future requirements will be the direction of chemical assistance. Major Roge address is "Chemical Warfare Service, Seventh a B. Streets, N. W., Washington, D. C."

Prof. Pierre de Peyster Ricketts, head of Ricke Inc., mineralogical and mining engineers, with offices 80 Maiden Lane, New York City, died recently at home, 115 East Seventy-ninth street, New York Ci

Make Paper From Leaves

Mme. Karen Dramson Suggests New Pulp Source

THE war has produced in France a very sharp rise in the price of paper. Before war broke out France imported over fifty per cent. of the pulp used by her manufacturers of paper from Germany and Austria. The cutting off of this source of supply, combined with the severe deforestation due to the war demand for lumber, made wood pulp so scarce and prices so high that many publications were compelled to suspend publication.

While the imminent coming of peace will no doubt eliminate some of the conditions which have made the present high price of paper in France possible, it seems likely that a scarcity of native grown wood pulp will persist in France for a great many years to come. It is likely, therefore, that a method of producing paper from fallen leaves evolved by French scientists under the stress of war time conditions will be made use of long after the war is over.

Some time ago M. Edmond Perrier, of the French Academy of Sciences, presented before that body an account of the successful experiments made along this line by Mme. Karen Dramson.

The process is very simple, rapid and inexpensive, according to M. Perrier. The leaves are first crushed by a proces which reduces the blades to a powder. This powder is carefully separated from the ribs and veins. From these the raw material for paper pulp is formed.

The ribs and veins are subjected, in the next proces of manufacture to a rapid lixiviation; then washed and bleached. The pulp is then ready for use.

The discoverer of this new material claims that it is for a number of uses in addition to its use as a paper material. First, it has a high food value, since it contains the digestible parts of the leaves with the cellulose removed. Its value as a cattle food is almost equal to that of hay, especially when mixed with molasses and compressed into cakes. Then it can be used as fuel. Compressed into cakes it may be used either with or without charcoal.

Mme. Bramson, in conection with the use of this powder as a fuel, recommends it further for treatment by means of dry distillation. Using this method she obtained a very pure charcoal, rich in calories, and easy to agglomerate. In using this process she also produced an excellent tar, having all the qualities of Norwegian tar. Other by-products were acetone and pyroligeneous acid.

One thousand grams of the leaves yielded, according to Mme. Bramson's figures 250 grams of pure carbon, 30 kilograms of tar, one kilogram of pyroligeneous acid and 600 grams of acetone.

The importance of this discovery on the part of Mme. Bramson can be seen when it is understood that France annually produces, according to estin ates made by the Director of the School of Grigo between thirty-five and forty million tons of dea leaves annually. It is further calculated that onl four million tons of these leaves would be neede to provide the paper pulp needed by France eac year. This would mean a very substantial saving t France as in 1913 she spent $20,000,000 for woc pulp all originating in either France or Austria.

It is believed that the collection of these leav could be carried on by women, children and cri pled soldiers. It is planned to either erect the mil needed for the preparation of the leaves, either i the vicinity of the forested areas of France or t ship the leaves in compressed form to centr depots.

Plan to Erect Laboratory

Plans involving the erection of a $500,000 centr laboratory building, to house some fifty labor tories, are under consideration by the Canadia Council for Scientific and Industrial Research. Th building it is planned to make the heart of a gre central industrial research institute, similar in fun tion to the Bureau of Standards at Washington a the Mellon Institute at Pittsburgh.

The scheme, which is considered essential to t future industrial development of the Dominion a the ability of the country to compete on an equ basis with the other industrial nations of the worl will, it is hoped, provide modern scientific equi ment for the investigation of Canada's raw m terials. It will serve as a national laboratory f the fixing of standards of all kinds, for the testi of materials and for the devising of methods utilizing by-products of industry at present waste

The War Industries Board has turned over the pr lem of increasing the country's potash supply to the I partment of the Interior. In announcing this chan Chairman Bernard Baruch said that this step was tak in order that a permanent department of the Administ tion might have charge of the task of emancipating American farmer from the grip of the German pot industry.

The Marcus Hook plant of the National Aniline a Chemical Company, Inc., has commenced construct on the village at Naaman's on the Delaware and work rapidly progressing on the first one hundred houses.

The Texas Gulf Sulphur Company is completing a 000 horse-power steam plant at Matagorda, Texas, in c nection with its plans for extensive development of sulphur mines. About 1,000 acres are to be developed w a daily output of 1,000 tons. It is planned to spend o $4,000,000 in development work at this point.

Losses amounting to $2,500 resulted on Nov. 13 fro fire which broke out in the laboratory of the Holl Aniline Dye Works, Holland, Michigan.

gloves, transparent nipples and other goods of that type are built up by making a thinner solution of the rubber compound and gasoline. This is applied to the surface of porcelain or wooden forms by dipping. In druggists' sundries such as water bottles, etc., the rubber is run into thin sheets, cut into shape and then worked together.

Vulcanizing Methods Used.

There are several methods of vulcanizing used in rubber factories. Rubber tires, tubes and products of that kind are placed in moulds. In the case of tires these moulds are placed in vulcanizers and steam is allowed to circulate around them. This process produces what is known as a moulded tire. In the wrapped tread tire, the tire after building is wrapped with wet cloths under high tension and the same process is applied as with the production of inner tubes, the tube being built up on a steel mandrel and then wrapped with cotton rags. Finally it is run into the vulcanizer and cured in steam of a given pressure.

In the production of mechanicals, such as valves, packages, etc., these are cured in a press. This press consists of two or more hollow plates through which steam circulates. The article to be cured is placed in a mould. This mould is placed between the two plates and steam allowed to circulate through the platens or hollow plates for a specified time at a fixed pressure.

Raincoats and goods of that kind are cured by being hung in rooms filled with steam pipes. The fabrics to be cured are subjected to the vapor of sulphur chloride for a fixed period. Rubber shoes and boots are cured by what is known as the heater process. Heaters are simply large rooms, which are heated to a given temperature by steam pipes, usually in the floors or around the walls near the bottom. A tire will be cured in one and a half to two and a half hours. It takes six to eight hours to cure a rubber shoe or boot by the heater process. Sometimes raincoats are cured in the same way by dry heat.

Finally we have the acid cure, applied principally to dipped goods and surgicals, where the sulphur chloride is dissolved in a solvent such as benzol or bisulphide of carbon. The goods are immersed in this solution for a few seconds, then hung up and allowed to dry, finally being stripped from the mould.

The Whitesboro plant of the Metallic Chemical Company has been closed and part of the workmen employed have been transferred to the company's Utica branch.

A branch of the Fabrico Co., of Dallas Texas is to be located in Quincy, Ill. The company manufactures a waterproof preparation for dressing leather belts, waterproofing tents, automobile tops and other fabrics.

Operations at the plant of the Stanley Anilin Chemical Company, Lockhaven, Pa., have been indefinitely suspended.

German Ownership Must Go

A. Mitchell Palmer Declares Against Return to Conditions

THAT the only hope for the future developm of the chemical industries of the Un States lay in the stamping out, root branch, of German owned companies in the Uni States, was the claim made by A. Mitchell Palm Alien Property Custodian, before the Bar Assoc tion of the City of New York, on the evening December 10.

"There is absolutely no hope," said Mr. Palm "for the development of American chemical ind tries under the old conditions. Chemistry m than any other science is the very foundation o far flung line of industry. You have but to lo about you, for example, at the tremendous p which colors play in all the necessities, comfo and luxuries of life to realize the grip which control of the dyestuff industry has upon the p ple. In peace and even more in war, chemis paints the whole picture of progress. Americ social and economic, possibly even her political dependence is not safe unless the industries pendent upon the development of the science chemistry are open to American genius and ener

"I cannot too forcibly repeat that the German dustrial penetration of America has not been mere friendly desire to trade and do business w the world. It has been a knife at the throat America. In the days before the war, and dur the war, most of the German-owned industrial tablishments were spy centers filled with the age of Germany long plotting against the safety of United States. They were depositories of sec information gleaned by the ubiquitous spies in German employ and without them these sp would have been almost harmless."

Mainly About Chemists

Mr. H. R. Van Wagener, of Denver, Colo., has b appointed general manager of the Canada Copper C pany and will make his headquarters at Copper Mount near Princeton, B. C.

Mr. M. H. Barnes, formerly chemist for the Illin Steel Company, Gary, Indiana, is now division inspec for the Aluminum Company of America, Maryville, T

Mr. Charles D. Test, until recently with the West Potash Works, of Antioch, Neb., has become attached the staff of the United States Tariff Commission.

Mr. Nathan Owitz, for four years general manager the J. P. Devine Company, of Buffalo, N. Y., has b appointed president and general manager of the Pe Chemical Corporation.

Mr. F. E. Smith has been appointed chief engineer w the Barber Greene Co., Aurora, Ill.

Mr. Benton Dales, formerly the head of the chemist department of the University of Nebraska, is now tached to the research department of the B. F. Goo rich Company, Akron, Ohio.

ULTRA VIOLET LIGHT

Its Application in Chemical Arts

By CARLETON ELLIS and A. A. WELLS[*]

Part XX

Massol and *Faucon* (Compt. rend., 1913, 157,386) have made a study of the ultra violet absorption spectra of some normal primary, secondary, and tertiary alcohols, and also of three abnormal primary alcohols. All the alcohols exhibit a progressive absorption for radiations of short wave-length. The secondary alcohols are slightly more transparent than the normal alcohols with the same carbon content, while the tertiary alcohols are markedly more transparent. Three abnormal primary alcohols, in addition to the normal absorption, show two distinct absorption bands lying at λ 2,500 — 2,700 A and at 3,060 to 3,150 A. These bands are special to the alcohols, and cannot be found either with the fundamental hydrocarbon, with the other alcohols, or with the corresponding alkyl haloids. The corresponding aldehydes present one single broad band coming between the two bands of the alcohols.

Drossbach (Ber. 1902, *35*, 1486) has extended his observations on ultra violet absorption spectra to salts of the rare earths and to several organic liquids. It is found that methyl and ethyl alcohol are completely transparent, while the higher alcohols have a more or less extensive absorption; propyl alcohol being 290; isobutyl alcohol 335; amyl alcohol 332, and allyl alcohol 310. The presence of traces of the higher alcohols in ethyl alcohol can be detected by this means. In the case of the aromatic hydrocarbons, the absorption by benzene is represented by 290; toluene, 288; xylene, 310; m-xylene, 307; mesitylene, 336. The ultra violet absorption very clearly distinguishes between the erbium and didymium groups of elements.

The absorption of ultra violet light by pure acetone has been investigated by *Clarke* and *Stewart* (Physikal. Zeitsch., 1913, *14*, 1049) using layers ranging in thickness from 50 to 400 mm. The curve which is obtained when the wave-length is plotted above λ 332 μμ, although there is a change in the slope of the curve at λ 336.5 μμ. In a note added by Stark it is claimed that this affords clear evidence of the long-wave ultra violet band, the existence of which he has previously anticipated.

Bielecki and Henri (Compt. rend. 1913, 156, 884) made photometric measurements of the spectrographs obtained from a condensed iron-cadmium spark, the light passing through either an aqueous or an alcoholic solution of acetone or through pure acetone, in layers of varying thickness, and determined the values of the molecular constant of absorption, e, in the formula $I=I_0ecd$ for values of λ from 2144 to 3706. The results show that acetone, in solutions, or in the liquid state, possesses only one absorption band in the ultra violet, the maximum being at λ 2706 for alcoholic solutions, and at λ 2648 for aqueous solutions, there being no indication of the second band mentioned by Gelbke. From calculation it is found that about one molecule in forty takes part in the absorption of the ultra violet light by acetone.

The conditions under which a point of inflexion can occur in an absorption spectrum curve have been investigated by *Stark* (Physikal. Zeitsch., 1913, *14*, 845) and it is shown that a point of inflexion in one branch of a band of an absorption boundary or an absorption index-wave-length curve is indicative of the presence of a less intense band in the same wave-length region as the first band. Acetone has a point of inflexion and it is concluded that this body has a less intensive ultra violet band above λ=330 μμ.

Saturated and Unsaturated Ketones and Aldehydes.

According to *Bielecki* and *Henri* (Ber., 1913, 46, 3627) the absorption curves of aliphatic ketones and aldehydes are characterized by an absorption band in the ultraviolet region between 2700 and 2800. The position of the maximum depends on the alkyl group. It is lowest in the simplest aldehydes, and increases regularly with the number of CH_2 groups. In the unsaturated ketones and aldehydes the ethylene linking causes a greater exaltation the nearer it is to the carbonyl. For shorter wave-lengths to the right of the maximum, acetone does not show a minimum until λ=2,144, aldehydes and the more complicated ketones show a minimum, and the absorption curve rises with the complexity of the alkyl. Comparison of the absorption curves of acids, ketones, and aldehydes indicates that the oxygen atom in carbonyl has its partial valencies free, whereas in carbonyl they are united with one another. In the absorption of rays of different wave-length the electrons of sometimes the one and sometimes the other atomic grouping come into play. Only a part of the molecules takes part in the absorption, and this part changes when the wave-length is altered. The ultra violet absorption of fourteen saturated aliphatic ketones has been investigated by *Rice* (Proc. Roy. Soc., 1914 (A), *91*, 76), who shows that the wave-lengths of the centres of the absorption bands depend on the number of methyl groups in the L and B positions relative to the carbonyl groups. Substitution of hydrogen atoms in the λ or further positions has no influence on the position of the band. Rice considers that these measurements show the existence of a relationship between the optical and the chemical properties. The observations are said to be in agreement with the theory that the ultra violet absorption is due to the electro-magnetic field of the carbonyl group as influenced by the substituents in the immediate neighborhood. The ultra violet absorption of a number of ketones has been examined by *Gelbke* (Jahrb. Radioaktiv. Elektronik., 1913, *10*, 1-34; J. Chem. Soc. 1913, Abs., *104*, ii, 87) the substance being dissolved for the most part in ethyl alcohol although in some cases the substances were investigated in the form of saturated vapor or dissolved in water or normal-hexane. From a comparison of the short-waved absorption bands of acetone and its substituted derivatives, it is found that the acetone band, which has its maximum at $\lambda=268$ $\mu\mu$, is displaced in the direction of greater wave-lengths when one or more hydrogen atoms are substituted by alkyl, halogen, phenyl, nitroso or carbonyl groups. In the case of alkyl substitution, the displacement of the maximum amounts to 5 — 10 $\mu\mu$. while the effect of halogens, the phenyl, nitroso and carbonyl groups is greater. The displacement of the band is accompanied by an increase in the absorption and also by a broadening of the band. From a comparison of acetone and cyclohexanone it appears that the influence of ring formation is comparatively small. In addition to the above-mentioned short-waved band, acetone shows a band with a maximum at about $\lambda=326$ $\mu\mu$, which extends from about $\lambda=327$ $\mu\mu$ into the visible spectrum. A similar band is also found in the substituted derivatives of acetone, and it is this which gives rise to the yellow color exhibited by many such substances which contain the carbonyl group. From a comparison of the absorption spectra of dimethyl diketone and methyl ethyl diketone with that of acetone, it is found that the short-waved band in the diketones is shifted about 5 — 10 $\mu\mu$ in the direction of longer wave-lengths, and that the absorption is considerably intensified. In regard to the long-waved band, the shift exhibited by the two a-diketones amounts to about 30 $\mu\mu$ and the intensity is increased about forty times. In the case of B-diketones the intensification of the long-waved absorption band is not nearly so great as that observed for the a-diketones. From a comparison of the spectra of methylheptenone, mesityl oxide, and phorone with that of acetone, it is found that both the short and long-waved bands are not appreciably shifted by a conjugated ethylene linking, although the intensity of the absorption increase vary considerably in both cases. If the ethylene linking is not conjugated, but separated from the carbonyl group by two methylene groups, the intensity of the short-waved band appears to be increased to a much smaller extent than when conjugation occurs.

---

[*] All rights of publication in book form reserved by the authors. Consulting Chemists and Chemical Engineers, 92-98 Greenwood Ave., Montclair, N. J.

A large number of substances have been examined in regard to the emission of fluorescent light when subjected to the action of intense utra vio radiation. These observations show that the act ity of the carbonyl group in this direction is qu general, fluorescence being exhibited by both mo and di-ketones, and by both cyclic and acyclic co pounds in which it occurs. It is thus proved t the faculty of fluorescence is by no means confin to ring compounds.

It is suggested by *Henderson* and *Heilbron* (Pr Roy. Soc., 1914, (A), 89, 414; J. Chem. Soc. 191 Abs., 106, ii, 84) that selective absorption of ult violet rays by ketones is caused by intramolecul vibrations due to the alternate formation and brea ing down of unstable ring systems, and that t momentary formation of these is affected throug the agency of free partial valencies which ma their appearance on the atoms of the compou under certain conditions.

In order to ascertain the way in which the absor tion of one chromophoric group is influenced by t presence of another, *Bielecki* and *Henri* (Ber., 191 *47*, 1960) have examined the absorption spect of acetone, dimethyl diketone, ethyl acetyglyoxala and acetonylacetone. Two carbonyl groups in t ∝-position have a hypsochromic action, equivale to about 160 Angstrom units, whereas in the λ po tion they exert only a hyperchromic action. Oth bodies considered are acetic, oxalic and succi acids, allylacetone, methylheptenone, methylis butye ketone, citral, phorone, benzaldehyde, ace phenone, furfuraldehyde and cyclohexanone.

Bielecki and *Henri* (Compt. rend., 1914, *158*, 1,02 have determined the molecular coefficients of sorption between 2,144 and 3,329 of acetone, d cetyl, ethyl diketobutyrate, acetylacetone, meth acetylacetone, and acetonylacetone in solution water, alcohol, dilute acid or alkali, and hexane, a for comparison mesityl oxide, methylhepteno and allylacetone, and from their results have dra the following conclusions. Acetone occurs in very small amount in its enolic form, CH_3.C(OH CH_2, in alkaline solution, the absorption be slightly greater in this medium. The presence a molecule of two carbonyl groups in conjug positions provokes a displacement towards the of the band characteristic of the carbonyl gro thus giving a hypsochrome effect. If the t groups are remote, as in acetonylacetone, there an increase in the absorption, but no displaceme that is, a hyperchrome effect. The absorpt spectrum of a B-diketone varies with the react of the medium and the nature of the solvent, behavior of these substances being explained if th are considered as a mixture of two forms, the p portions of which vary with the solvent.

Bielecki and *Henri* (Compt. rend., 1913, *156*, 1,32 have determined the molecular coefficients of absorpt

(Continued on page 521.)

107 .

INDEX

The Chemical Engineer

VOLUME XXVI, January, 1918, to December, 1918

- Acid, Benzone *sulphonic, manufacture of*................ 258
  - carbolic *and salicylic in antiseptic gauze*.......... 174
  - chromotropic, *new azo dyes from*.................. 298
  - Di-amino—naphthol—sulfonic—*new dyestuffs from* 175
  - free. *The estimation of, in solution*................ 28
  - hydrocyanic. *Manufacturing tests of cotton fumigated with* 104
  - hydrocyanic. *Process for fumigated baled cotton*.... 37
  - nitrous. *Dyeing of means of*...................... 303
  - phosphomolybdic. *Use of, in producing color lakes*.. 226
  - picric, *and other nitrated phenols*................. 22
  - picric. *Explosions of*.......................... 257
  - picric, *from certain gums*....................... 141
  - picric. *Quantitive estimation of*.................. 220
  - picric. *Recovery of, from wash water*............ 171
  - phthalic, *and its anhydride*...................... 187
  - salicylic *and carbolic in gauzes*................... 174
  - sulfonic. *An improved method of separating*........ 221
  - sulfonic, *from sulfuric acid*..................... 171
  - sulfonic. *Manufacture of* 129
  - tungstic. *Color lakes derived from complex*........ 225
- Acridine dyestuffs. *Disinfectants derived from*.......... 141
- Acridine dyestuffs *for use as bactericides*.............. 147
- Aetna Explosives Company............................ 127
- Algarrobin 301
- American Electrochemical Society, *annual meeting*...... 113
- Ammatto. *Porto Rican* 206
- Amido-oxy-aromatic compounds....................... 221
- Ammonium sulphate. *Shortage for Japan of*............ 66
- Aniline black, *new*.................................... 427
  - *Dyes in the U. S.*............................... 34
  - *Dimethyl, monomethyl and diphmylamine*........... 174
- America's Chemical Progress........................... 126
- Anthracene. *The manufacture of*..................... 247
- Anthraquinone. *Amino* 221
- Antipyrectic-*stimulants* 272
- Apparatus. *The American manufacture of laboratory*.. 275
- Archil Extract *in the U. S.. The manufacture of*........ 268
- Arseno—phosphorus *new compounds*.................. 272
- Artificial Silk 417
- Aspirin. *Suit over use as trademark*................. 142
- Azo Colors—*a new class of yellow*.................... 224
  - *Use on vegetable fibres*.......................... 225
  - *a new series of ortho-oxy*........................ 259
  - *new insoluble*................................... 175

- Barium and radium, *conversion to carbonates*............ 66
- Barks, *comparative tests with mangrove and wattle*.... 69
- Barrett Company. *Explosion in plant of the*........... 127
- Bayer and Company. *Works at Rennselaer, N. Y.*....... 265
- Benzene and toluene *for high explosives*................ 249
- Benzene Derivatives, *Toxicity of*........................ 174
- Benzols, *crude* 12
- Benzol *in gas. Estimation of*.......................... 254
- Benzol Plant. *New*.................................... 273
- Benzol—*Standard Tests in Color Works*................ 127
- Benzyl Chloride. *Manufacture of*..................... 272
- B—Napthol—*Derivatives as Disinfectants*............... 172

- Cadmium *derivatives as bactericides*.................. 147
- Carotin. *Toxicity of* 304
- Cellulose Yarn. *Germons using*....................... 41
- Chemical Control *in the leather industry*................ 1
- Chemical Industry. *Outlook for British*................ 30
- Chemical Investigation Department,
  33, 77, 115, 155, 197, 237, 272, 31
- Chemical Progress. *America's*......................... 12
- Chemical Warfare Service.............................. 37
- Chemicals, *export trade after the war*.................. 1
  - *British imports and exports*...................... 14
- Chemist and the Fertilizer Industry. *The*.............
- Chemistry. Commercial ....
- Chemistry and Engineering............................ 1
- Chrome Mordant. *New method for use of*.............. 1
- Coal Tar. *The British supply of*...................... 2
  - *Progress of Canadian industry*.................... 3
  - *Chemists to advise government*.................... 1
  - *Growth of industry in foreign countries*............ 1
- Coal Tar. *Color industry of England*.................. 1
  - *Expansion of American industry*.................. 2
  - *Compounds. Analytical studies of*................ 1
  - *Dyes for leather*................................ 1
  - *Dyes as medicines*............................... 1
  - *Development of U. S. industry*.................... 11
  - *German industry* 2
  - *Electrolytic production of intermediates*........... 1
  - *Leeds firm buys plant*........................... 11
  - *Research at Huddersfield*......................... 1
  - *Synthetic drugs from*............................. 1
- Color Concentrations and Values. *The standardization*.. 1
- Color Industry, *profits of British*...................... 1
  - *profits of Swiss*................................. 1
- Color Patents *in Great Britain*........................ 1
- Color Technology. *The physical basis of*.............. 2
- Calorimetric Test *for determination of organic impurities in sand* ....
- Coloring Material from Rice Leaves.................... 3
- Coloring Substances. *Examination of food*............ 1
- Colors for Army Uniforms............................ 2
- Colors, German Amalgamation of Manufacturers...... 2
- Colors. The Estimation of Coal Tar.................... 2
- Colors. Natural. *References to articles on*..............
- Colors. *Proposal to modify tariff on*.................. 1
- Colors. *Purity ond strength of American*.............. 2
- Commercial Development *of Technical Trades*..........
- Cotton Fumigated *with hydrocyanic acid*.............. 1
- Cream of Tartar, *crystallization in grapes*...............
- Cross Index of *chemical terms*....................... 4
- Crudes in Australia *coal tar*.......................... 2
- Coal. *Volatile products of*...........................
- Di-azo Dyestuffs. *New wool* 2
- Disease, Industrial, *of explosive industries*.............. 1
- Divi-divi. *Extract of*................................ 3
- Drugs. *Analysis of synthetic*.......................... 1
- Drugs. *Coal tar*...................................... 1
- Dye. *New discoveries of*............................. 1
  - *Works in Jamaica*................................ 3
  - *Theft of formulas*................................ 2
  - *Strength of English industry*....................... 2
- Dyeing. *Apparatus for*............................... 3
  - *Art of* 2
  - *Khaki* 2

  Nitrous acid and metallic salts in 303
  Papers on 177
Dyes, *American, after the war* 26
  American development of industry 75
  Chromotropic acid 298
  Chinese industry 267
  New aniline black 427
  New sulphur black 177
  Patent blue, new class of 299
Dyes. *Use of vegetable, by U. S.* 138
Dyestuffs. *American industry* 260
  American industry, the development of 110
  American industry, a new factor in 204
  Amino-naphthol-sulphic acid 175
  Antiseptics 175
  British Government control of industry 224
  British industry, revival of the 17
  Copper compounds of ortho-oxy-azo 298
  French industry, the revival of the 19
  Japanese industry 20
  Japanese competition 11
  Leather 176
  Philippine vegetable 21
  Seaweed as a 21
  Swiss industry in 1916 19
  Yacca gum and Congo resin 177
  Women and 244

Eastern States Exposition 166
Educational Policy *of Great Britain* 423
Electrochemical Society. *The American* 113
Electrolytic, *Production of coal tar intermediates* 128
Engineering and Chemistry 18
Estimation of Free Acid *in solutions* 28
Explosibility of Pyrites 181
Explosion *in an aniline plant* 169
  in Barrett plant 127
  in the Beckers' works 230
Explosion *in the Midvale Company's works* 230
Explosions *of oxygen. Government investigation of* 38
Explosives: *The German coal tar industry and* 254
Explosives. *Disease incident to manufacture of* 172
Explosives. *Nitron as a gravimetric reagent in analysis of materials of* 90
Export Licenses 208
Exposition of Chemical Industries......153, 166, 235, 282, 408

Fertilizer Crisis. *The* 86
Filtration *and glass cloth* 371
Flotation. *A new process of oil* 67
Food Coloring Substances 175
Fumigating Baled Cotton 37
Gasoline. *Government tests of* 192
German Artificial Color Industry 208
German Manufacturers *use cellulose yarn* 415
Glass Cloth *and filtration* 371
Glass Mixtures. *Studies of.* 114
Glycerine. *The recovery of* 31
Gum Arabic *and its quantative determination* 2

Index of Chemical Terms. *Cross* 416
Indicator. *A new and sensitive* 258
Indigo. *American synthetic* 135
  Central American cultivation of 304
Indigo *industry in India* 300
  Natural 137
  Use of bacteria in the preparation of natural 302
Isakovics. *Death of Alois van* 178

Lakes *derived from tungstic acids* 225
Lakes *in the Dihydro-anthroquinone series* 177
Lead Ores *of low grade* 74
Leather. *Dyestuffs for* 176
Leather Industry. *Chemical control in the* 12
Lignite Survey 496

Mangrove and Wattle Barks. *Comparative tests with*.. 69
Merger of Coal Tar Manufacturers..........122, 167
Mesothorum 511

Naphtha. *The cracking of solvent* 168
Naphthalene *for use as insecticide* 169
Naphthols. *Differentiation of the two* 220
National Aniline and Chemical Co.'s *new location* 246
Nitrate of Ammonia 451
Nitrated Phenols. *The preparation of* 22
Nitro-Carbazole 174
Nitron *as a gravimetric reagent* 9

Oakes Company *to build* 14
Occlusion of Gases 49
Oil and *a new series of flotative agents* 6
Oils. *The recovery of light* 37
Oils *in Southern China* 6
Organic Symbols. *A shorthand system of* 37
Oxygen. *Government investigation of explosions* 3

Paper pulp. *Lallang grass as a source of* 1
Paper from Leaves 50
Patent Law. *Proposal to waive* 14
Peat. *Clothing from* 7
Perfumes. *The increased cost of* 27
  British manufacture of synthetic 13
  Production of synthetic 17
Petroleum. *Government report on oil bearing shales* 10
Phenol. *American made* 20
  Artificial 24
  Cyclic process for manufacture of 12
  Determination of in carbolic acid crude 20
  Preparation of nitrated 2
  Tanning materials from 38

Phosgen. *The manufacture of* 22
Photographic *developers. The production of* 14
Phthalic Acid *and its anyhydride. New methods of producing* 18
Picric Acid. *Explosions of* 25
  Preparation of 2
  Quantative estimation of 22
  Wash water. Recovery of picric acid from 17
  Works in Great Britain 1
Platinum Consumption *of the U. S.* 19
Potash *from banana stalks* 8
Potash Noose. *The* 84
Potash Situation 45
Pyrites. *The determination of the explosibility* 18

Radium. *Conversion of radium and barium to carbonates* 6
Reconstruction Meeting 45
Refractories *and glass mixtures being studied* 11
Research. *Cooperation in* 243
  Nationality and chemical 143
  The organization of national 201
Rosin. *New dyestuffs from Congo* 17
Rice Leaves. *The coloring material of* 30
Rubber Manufacturing Processes 49

Saccharin. *The French duty on* 14
  Limited use in France 17
  Role during the war 2
Salicyic Acid Vapor. *A method for the condensing of*.. 38
Salvarsan 17
Sodium salicylate. *New method for the preparation of* 17
Standardization of Benzol Tests *in coke works* 12

Stimulants. *Antipyretic* 272
Sulfonating Kettles 254
Sulfonic Acids. *The manufacture of*.................. 129
Sulfotitanium 220
Sulphur Dyes 177
Swiss Color Industry...................................... 245

Tanning Materials from Phenol.......................... 387
Tar Distillation. *Improvement in* 169
Tar Industry in Great Britain............................ 12
Tartar in Grapes 15
Technochemical Problems of Today.................... 62
Tennis Star *becomes industrial chemist*.............. 74
Textiles. *A foaming process for testing*.............. 303
Theft of Dye Formulas.................................... 273
Toluene *The American supply of*...................... 207
  The estimation of..................................... 168
  Some sources of 249
  Recovery from illuminating gas...................... 250
Trinitro toluene. *The evolution of*..................... 170

Ultra Violet Light: *Its application in the chemical arts,* 2, 54, 95, 148, 188, 232 311, 385, 465, 505
Uranium Oxide. *The preparation of*.................... 109

Waste Disposal Plants. *The improvement of* 16
Women and Dyestuffs 244
Yellows. *A new series of sulphur*...................... 224

Occlusion of Gases

(Continued from page 500.)

by vaporizing some metallic calcium. O. W. Richardson has, however, given evidence in many papers that thermionic emission from heated metals in an intrinsic property of pure metals. Irving Langmuir has made elaborate investigations during the last few years and he concludes that contact potentials of large magnitude do exist even between pure metals in a practically perfect vacuum. The evidence is obtained by the study of (1) electron emission from heated metals (2) photoelectric phenomena (3) contact potentials. Several independent methods lead to values for the contact potentials which are in substantial agreement. This modern work has completely reopened the vexed question of the Volta potential as put forward by Volta himself and supported by Lord Kelvin as a most powerful protagonist: and as opposed by Faraday. Maxwell and the majority of the chemical school with the exception of the chemists in France.

Chinese Wolframite Mines Grow

The deposits of wolframite in South China, according to information in the hands of the Bureau of Domestic and Foreign Commerce, under the pressure of a war made demand have been developed remarkably during the past year. Shipments from Hong Kong alone, not including Swatow, Canton and other points transshipping through Shanghai and other points of transshipment have totaled $1,831,590 gold, so far the current year, the ore generally being valued at $1,000 gold a ton.

According to Chinese reports the industry has reached the dimensions of a veritable boom.

Chemical Warfare Service

Maj.-General Seibert Reviews Work of Service Since Its Inception

HAD the war continued, by next spring America would have deluged the Germany army with poison gas, according to statements made at a dinner given on the evening of December 13 by the commissioned officers of the Chemical Warfare Service to Major General William L. Siebert, director of the service.

Summing up the accomplishments of the service since its inception, General Siebert said in part:

"The Chemical Warfare Service came into existence as such July 13, 1918, by executive order. On Nov. 11 plants for the manufacture of the standard gases were in operation with a manufacturing capacity greater than that of England and France combined, which capacity would have been trebled in the case of certain gases before the beginning of the new year.

"Several other endeavors in the toxic field were just coming into production, and had the war continued until the spring of 1919 we would have subjected the Germans to a deluge of toxic substances such as they never dreamed possible when they commenced this type of warfare.

"This gas production record made by a nation that had not devoted its attention to chemical matters in the past is something to be proud of and something indicative as to the future. Before the war the world looked to Germany in chemical matters, and among the great nations America especially was looked upon as most backward in such matters.

"It is hoped that one of the great results will be to give capital confidence in the ability of our chemical engineers to manufacture chemical substances at a cost that will compete with other nations.

"This war has shown that chemical engineering is the greatest undeveloped field of industry in the United States, and no nation can afford to permit such great possibilities to lie fallow. Our colleges, therefore, should make a specialty of chemical engineering."

Col. W. H. Walker, chief of the Gas Production Branch of the Service, told of the gasses made at the Edgewood arsenal. At the time the armistice had been signed shiploads of gas-loaded shells were going to Europe and hundreds of containers of gas were being piled up.

Col. Bradley Dewey, in charge of the production of gas masks, said that a gas mask had been evolved without nose or mouthpiece. A man could wear it indefinitely.

Mr. T. A. Lawton, 17 Battery Place, New York City, has been appointed New York representative of the American Creosoting Company

INCORPORATIONS

THE coming of peace has apparently had little effect on the formation of new corporations chartered to manufacture chemicals and allied products. Reports from the capitals of the various states would serve to indicate that capital seeking investment retains its faith in the future possibilities of the chemical industries of this country.

DELAWARE

The Washington Dye and Chemical Corporation has been incorporated under the laws of Delaware with an authorized capital of $150,000. The incorporators are O. J. Ricketts, J. D. Hird, and George T. Parker, all of Washington, D. C.

Maree-Roze Manufacturing Company, Wilmington, Delaware, has been incorporated with an authorized capital of $100,000 and will carry on the business of soap manufacturing.

The Prockter-Price Soap Company, of Dover, Delaware, has been incorporated with an authorized capital of $75,000. The new corporation will manufacture soaps and toilet articles of all kinds.

The St. Jacobs Oil Co. has been incorporated in Delaware with a capital of $300,000.

The American Potash and Nitrate Corporation has been formed under the laws of Delaware with a capitalization of $500,000. Incorporators: Robert Hobart, C. Fash, James F. Starck, Elisha W. Keely, of New York.

The Walter Luther Dodge Co., drugs, chemicals, etc., has been incorporated under the laws of Delaware with a capital of $320,000.

The Republic Match Company has been incorporated under the laws of Delaware with a capital of $40,000.

Kali Company of America, potash, etc., has been incorporated under the laws of Delaware with a capital of $1,000,000. Incorporators: Stuart H. McIntosh, Joseph W. Henry, Thomas Robinson, all of New York.

The Sun Chemical and Color Company, of Wilmington, Delaware, has been incorporated with a capital of $100,000. The new firm will manufacture paints, dry colors and stains and similar materials.

The Pauver Company, manufacturers of chemical products, have been incorporated under the laws of Delaware with a capital of $10,000. The incorporators are M. A. Meyrcord, John E. Fleming and Ira G. Ross, all of Philadelphia

MAINE

The Abbott Chemical Company has been organized under the laws of the State of Maine, with an authorized capital of $50,000. The new company, which is headed by Mr M F Hearin, of Augusta, Me., will take over and conduct the business of the Abbott Chemical Company and the Abbott Marshall Company.

NEW JERSEY

The Keystone Solether Corporation, of Trenton, New Jersey, has been incorporated with a capital of $250,000 to manufacture synthetic and artificial leathers, floor coverings, etc.

Acme Graphite Mining Co., of Westfield, N. J., has been incorporated with a capital of $100,000. Incorporators: W. M. Hoag, of Westfield, and George C. Angel and A. S. Sayes, of New York city.

The Kinsey Chemical Company, of Jersey City, New Jersey, has been incorporated with a capital of $100,000 to manufacture chemicals.

NEW YORK

The North American Industrial Transatlantic, Inc., Manhattan, has been incorporated with an authorized capital of $50,000. The company will manufacture dyestuffs. The incorporators are R. Illowy, E. M. Waldo, A. Gabriel, all of 670 Sixth avenue.

Proco Chemical Company, of Manhattan, has been incorporated by P. Webb, M. and C. H. Brown, 2043 Bathgate avenue, Bronx.

J. F. Chapman & Co., of Manhattan, acids, chemicals, etc., have been incorporated with 100 shares of preferred stock, par value $100, and five shares common stock, no par value; active capital, $75,240.

American Nitration Company, of Newark, N. J., has been incorporated with a capital of $50,000 to deal in alkalies, chemicals, etc. The incorporators are D. L. Summey, Waterbury, Conn.; Alfred Weeks, Nutley; William A. Wachenfield, of Newark, N. J.

The Fatty Acid Reduction Company, of Syracuse, has been incorporated with a capital of $200,000.

The St. Regis Falls Wood Corporation, of Watertown, N. Y., makers of pulp and wood products, has been incorporated with an authorized capital of $30,000. The incorporators are F. L. Carlisle, B. G. Martin and R. K. Ferguson, all of Watertown.

American Drying Process, Inc., of Manhattan, chemical preparations, etc., has been formed under the laws of this State with a capital of $10,000. Incorporators: E. A. Zema, T. A. McCarthy, W. F. Delaney, 20 Vesey street.

The Post South Sales Company, of Buffalo, has been incorporated with an authorized capital of $10,000 to handle chemicals and allied products.

The Nico Chemical Corporation, of Manhattan, has been incorporated with an authorized capital of $100,000 to manufacture potash, explosives, dyes and chemicals. The incorporators are J. T. Fenlon, 169 Secor street, Pelham; S. Klein, 55 Liberty street, New York City, and H. L. Schaefer, Sea Cliff, N. J.

Berner-Geiger, Inc., of Queens, drugs, chemicals, etc., has been incorporated under the laws of New York with a capital of $10,000. Incorporators: J. Geiger, I. M. Schwartz, N. Berner, 130 Rivington street.

PENNSYLVANIA

The Standard Chemical Company, of Reading, Pa., has been incorporated with a capital of $100,000. Jacob H. Reichert is the president of the new corporation.

TEXAS

The Purity Serum Company, of Fort Worth, Texas, has been incorporated with an authorized capital of $150,000. John Kennedy is the president of the new firm.

VIRGINIA

The Cumberland Chemical Company capitalized at $100,000 has been chartered at Bristol, Virginia. E. W. Pendleton is president of the new company and E. R. Levy, of New York City, the secretary-treasurer. The firm will have a New York office.

Mesothorium Radium Substitute

Welsbach Company Now Turning Out Mineral in Large Quantities

THE increasing demand for radium for medical work, but more particularly for luminous paint, has made the quesion of possible radium substitutes of considerable importance. Radium luminous paint has been used in the war for a number of purposes, more particularly on the dials of instruments used on airplanes, so that these instruments can be read at night; for electric push buttons, door numbers and small images for shrines, etc. The paint is permanently luminous in the dark and contains from 0.1 to 0.25 milligrams radium element to one gram of zinc sulphide. A luminous watch face usually has from ten cents to twenty cents of radium on it.

An excellent substitute for radium for certain purposes is meso-thorium. This is a radio-active element found in monazite sand and other thorium minerals. When first extracted it is not in a satisfactory condition for luminous paint, but must be allowed to "ripen" for several months or even a year before it can be used. During this time the Alpha radiation which is required for luminous paint becomes sufficiently strong. On the other hand the beta and gamma radiation of meso-thorium grows rapidly and it can be used for medical purposes within a few days after preparation.

Radium has a long life, half of it decaying in approximately 1600 years. Meso-thorium on the other hand has a short life, 5 or 6 years being its useful life for luminous paint purposes. The price in the past has varied from 40 to 60 per cent. of that of radium, the comparison being on products of equal activity. For medical purposes, therefore, it cannot compete with radium as long as there is plenty of the latter; for luminous paint, to be used on objects which themselves have a short life, it is an excellent substitute for radium and will tend towards the saving of radium for medical purposes.

It undoubtedly has been used during the war especially by the Germans. Some of the first luminous watch dials in this country probably contained meso-thorium imported from Europe.

Until recently no meso-thorium was recovered in the United States, although large quantities of monazite sand are annually treated for the manufacture of incandescent gas mantels. Such a condition has represented an important mineral waste.

Shortly after the United States entered the war the Bureau of Mines made a co-operative agreement with the Welsbach Company of Gloucester, N. J., for the study of methods of extraction and recovery of meso-thorium. The work was carried on at the Rocky Mountain station of the Bureau of Mines at Golden, Colo., under the direction of Dr. R. B. Moore, Superintendent of the station, Dr. Herman Schlundt being assigned to the detailed work on the problem. Successful methods of extraction and recovery have been worked out and connected up with the regular metallurgical processes of the Welsbach Company. Meso-thorium is now one of the regular products made by this company. The next largest producers of thorium salts in the country about the same time became interested in the recovery of meso-thorium and worked out its own methods. Consequently at the present time meso-thorium is recovered from practically all the monazite sand treated in the United States.

The details of the work of the Bureau of Mines will be published later. A preliminary announcement was made by Dr. Moore in a paper given at the September meeting of the American Institute of Mining Engineers at Colorado Springs.

The Bureau of Mines has never claimed the discovery of meso-thorium as this element was first identified and described by Hahn in 1905.

Census of Research Laboratories

With a view to ascertaining the location and resources of all laboratories in the United States capable of being used in industrial research work, Mr. Alfred D. Flinn, secretary of the Engineering Foundation, is seeking all available information regarding them on behalf of the joint committee of the Engineering Foundation and National Research Council on Promotion of Industrial Research. Readers of The Chemical Engineer having laboratories not already listed by The Engineering Foundation are asked as a patriotic duty to communicate with Mr. Flinn at 33 West Thirty-ninth Street, New York City.

The Home Market Club of Boston, of which Thomas O. Marvin is secretary, at its annual meeting held recently, placed itself on record as opposed in the most emphatic way to the importation of German made goods in the United States after the signing of the final peace treaty.

The Club further stated its belief that American industries should use American dyes and that the Government should protect the American dyestuff and chemical industries by an adequate tariff and other means of regulation.

The results of the labors of the staff which under the guidance of Dr. F. R. Pickerell, chief chemist of the United States appraisers' stores of the port of New York, have been engaged in compiling a census of the chemical imports during the fiscal year, will, according to the Commerce Reports of the Bureau of Foreign and Domestic Commerce, shortly be ready for publication. According to this authority, this census has been a tremendous undertaking as over 20,000 invoices of chemical imports had to be segregated from invoices of general imports.

Using Many Substitutes

British Make Successful Use of New Paper Materials

SCARCITY of raw materials, due primarily to war conditions, has affected a wide use of substitute materials in all parts of Great Britain.

In this substitution program paper has paid a very important part. It has been found particularly useful as a substitute for jute. India, England's only source of jute, was several thousand miles away and shipping had, due to the exigencies of war, to be materially curtailed. While the supply of jute had to be cut radically there was simulataneously an equally abnormal demand from those articles in whose manufacture jute is principally used.

Thanks to the fact that efficient machinery for the manufacture of paper textiles developed in Great Britain before the war broke, the industries of the country were able to rise, without a great deal of difficulty to the emergency.

Today paper bags are being used as containers for potatoes, seed, fertilizer, coffee, sugar and grain. In appearance and quality these paper bags are not unlike the jute article but with the advantage that as in the case of the burlap article there are no loose fibres to mix with the contents of the containers. While the new bags cannot of course be moved about by means of hooks as are the burlap article, this difficulty has been surmounted by the placing of lugs on the corners of the bags.

Today an extensive use is also being made in Great Britain of paper as a substitute material in the packing of biscuits, jams and other food products and a paper substitute for window glass has been perfected that has met with much favor in the army huts in France.

Thanks to the fact that there has not been any serious shortage of cotton and wool in Great Britain during the war, the making of paper textiles for clothing has not been developed to the extent it has in Germany. So far only vests, sou' westers, capes and waders have been made of paper materials in this country.

English manufacturers are not inclined to believe that the paper textile industry will threaten to any serious extent the stability of the true textile industry in the near future. While the substitution of paper textiles for the real articles have played no small part in the successful prosecution of the war, it seems hardly likely that paper textiles will replace anything but a certain proportion of jute and hemp.

Taylor, Lowenstein & Co., of Citronelle, Ala., have purchased 800 acres of timber land and will extract turpentine

To Make Caustic in Brazil

American Corporation Buys Site Near Santos—Mill to Cost $500,000

AN American company is to erect a factory in Brazil for the manufacture of caustic soda and other chemicals, according to consular reports from Rio de Janeiro. The company has already purchased 720,000 square meters of land near the city of Santos.

The total capital involved is said to be about $500,000, of which 50 per cent. is to be raised locally and the other 50 per cent. furnished by the company in the United States which is to supply the necessary machinery. The proposal of the government of Sao Paulo states that the company will build the necessary facilities for the manufacture of caustic soda, consisting of twelve buildings measuring between 90 and 2,300 square meters each, an administration building, houses for workmen, night schools for children, and an industrial school for the adult laborers, all these buildings to be built according to modern industrial and hygienic plans.

The factory under full operation is estimated to produce daily 15 tons of caustic soda, 15 tons of chloride of lime, 600 kilos of muriatic acid, and 600 kilos of chlorate of potash. In these operations the company will use each day 25 tons of salt, 10 tons of lime, 400 kilos of muriate of potash, and 3 tons of charcoal.

Want German Patents

E. I. du Pont de Nemours Apply for German Dye Stuff Rights

The E. I. Du Pont De Nemours & Company, Wilmington, Delaware, asked the Federal Trade Commission for licenses to use German-owned or controlled patents covering acids, dyes and processes for making them.

At the same time, E. C. Klipstein & Sons Company, New York City, asked for license to use a patent for "The Process of Bating Hides"; and the Phenarsenyl Distributing Company of New York, Inc., applied for two licenses covering acids manufacture.

The patents were issued by the U. S. Patent office at various times from 1909 to 1914, to German firms or their assignors of Darmstadt, Frankfort-on-the-Main, Offenbach-on-the-Main, and Ludwigshafen-on-theRhine, Germany.

The Du Pont license applications are for use of patents on the following: "Producing Ice Colors," "Stable Indigo-White and Process of Making Same," "Compounds of Leuco Vat Dyes With Aralkyl Compounds and Process of Making Same," "Reducing Indigo Coloring-Matters," "Aromatic Ammonium Compounds and Process of Making Same," "Azo Dyes from the Arylamids of 2.3-Oxynaphthoic Acid and Process of Making Them," and "Condensation Products from the Arylamids of 2.3-Oxynaphthoic Acid and Formaldehyde and Azo Dyestuffs Therefrom and Process of Making Same."

The picric acid plant now in course of construction in North Brunswick, Georgia, will be completed, according to Washington reports, and will be used to manufacture dyestuffs, fertilizer and other byproducts of the process of picric acid manufacture.

Manufacture of Straw Paper

Will Growing Scarcity of Wood Revive Industry?

THE recent prophecy on the part of an old-time paper manufacturer, that the growing scarcity of soft woods in the United States would result eventually in a revival of the American straw paper industry, sounds interesting in these days when ways and means of handling by-products and substitutes of various kinds is so much to the fore. The last straw paper mill in the United States closed its doors in 1903. The principal cause of the decline of the industry was the competition of wood pulp paper and the invention of the various devices for the turning out of cheap paper. The causes which would possibly put it on its feet again would be a continued rise in the cost of the wood pulp product, a continued rise which is well within the realm of possibility, in these days of high prices and raw material scarcity. Further, large supplies of the fibre from which straw paper is made can be raised on the land annually, while it takes many years to replace a tree.

Previous to the Civil War all the newspapers of the country were printed on straw paper, and at one time there were as many as sixty plants making this kind of paper. It is well within the memory of most people now living, when brown straw wrapping paper was to be found on the counters of most of the stores in the country. Today this product would be a curosity if it were encountered.

Old-Time Paper Making.

In those days the process of paper making was a rather slow and cumbersome business. To make paper this pulp was floated in vats, at the side of which stood the workmen, mould in hand. This mould was of wire cloth, around the outer edges of which a rim was formed by superimposing a thin frame called a "deckle," which prevented the pulp from flowing off and left the water no other escape than through the bottom of the mould. Into this the pulp was dipped and as the water drained away the pulp was left in the form of a thin layer covering the bottom of the mould. At this point it was given to another man—a workman known as the "coucher"—whose duty it was to remove the mould. This was done by the application of a piece of felt to which the pulp adhered in the form of a thin sheet. A second piece of felt was then placed on top of this and to this felt another pulp mould was applied, and this process was continued until the pile of alternate layers of pulp and felt had attained the requisite height.

Method of Drying.

From this pile, or "post," as it was called, all the water was thoroughly expressed and the pulp, separated from the felt, was pressed and hung upon the "tribbles," or lines in the drying room. This portion of the process completed, the sheets were still rough and somewhat like blotting paper, so it was necessary to dip them in size and to press and dry them again before they assumed the character of a finished product.

Paper making is one of the oldest of the American industries. As early as 1690 William Rittenhuysen, an experienced paper maker from Holland, in partnership with William Bradford, a Philadelphia printer, opened the first paper mill ever established on American soil. It was located on a stream since known as Paper Mill Run, near Philadelphia. and there a fair quality of paper was manufactured out of the rags of the home-grown flax. Of course, the method was very primitive, and it was not until 1756 that the first pulp engine to be introduced in this country was imported from Holland.

In 1794 a large paper mill was established at Troy by Websters, Ensign & Seymour, and during the same year a mill for the manufacture of coarse wrapping paper from the bark of the basswood tree was opened at Fairhaven, Vt., by Matthew Lyon. As this was the first establishment in the United States to attempt to make use of anything except rags for pulp, the enterprise attracted no little attention.

Coming of Straw Paper.

The general use of straw paper began in 1857. Some three years previous to that time a Frenchman named A. C. Mellier had succeeded in converting several vegetable fibres, notably straw, into pulp, which he believed would be suitable for use in the manufacture of paper. The process, which has since borne his name, was neither a difficult nor costly one. The straw was first thoroughly soaked and after it had been cleaned it was boiled at a temperature of not less than 310 degrees Fahrenheit, in a solution of about 4 per cent. of caustic soda. Although, Mellier peddled his idea from one end of the country to the other, the big manufacturers of paper did not seem to consider the scheme a practicable one, and three years, therefore, elapsed before he was able to persuade anybody to invest money in his project.

The man who finally undertook to make paper by this process was J. B. Palser, a member of the firm of Howard & Palser, and the factory they established at Fort Edward, N. Y., for the express purpose of carrying Mellier's idea into effect, proved an excellent investment.

A fish fertilizer factory is to be built at Morehead Bay, N. C. The new plant when completed will have a capacity of 50,000 fish an hour.

Chemical Exports Increase

Since Opening of 1914 U. S. Exports Have Increased Over 600 Per Cent.

Since the outbreak of the war in Europe, the annual exportation of chemicals from the United States has increased over 648 per cent. In the year preceding the war the exports totalled $27,000,000; in the year which ends with the current month the exports will total $175,000,000.

A compilation by the National City Bank of New York shows that the value of chemicals exported steadily grew from the beginning of the war, and, as above indicated, will approximate $175,000,000 in the current year, against about $27,000,000 in the year immediately preceding the war.

The United States has always been a large importer of chemicals, the total value of this class of merchandise imported prior to the war being about three, and in some instances as much as four times the exports, and while the demands of the war have been such as to somewhat stimulate the importation, meantime the percentage in the growth in imports has been small compared with the percentage of growth in exports. The imports grouped under the head of chemicals consist largely of classes of materials not produced in the United States, and included in the fiscal year 1918, $70,000,000 worth of nitrate of soda, a Chilian product, and $22,000,000 worth of gums, strictly tropical products.

Eliminating these strictly tropical article which have been classed by the Government of "Chemicals," the present importation of manufactured chemicals is extremely small, indicating that our own manufacturers are at present supplying the great markets for chemicals in the United States, and at the same time sending nearly $150,000,000 worth a year to foreign markets. In the full fiscal year 1918 the chemicals exported aggregated in value $152,000,000, against $27,000,000 in the year preceding the war, $46,000,000 in the first year of the war and $124,000,000 in the second year of the war.

Dyestuffs and Dyes.

The most striking feature of this growth in the exportation of chemicals occurs in dyes and dyestuffs, of which the United States was, prior to the war, an extremely small exporter and a very large importer. The total value of dyestuffs exported in the fiscal year 1918 was $17,000,000, against $12,000,000 in 1917, $5,000,000 in 1916, $1,000,000 in 1915 and less than $500,000 in 1914, the year preceding the war. Prior to the war the exportation of dyes and dyestuffs had never exceeded about $500,000, while imports of dyestuffs prior to the war aggregated from $10,000,000 to $15,000,000 per annum.

Dyestuffs exported to Great Britain in the fiscal year 1918 total over $2,500,000, against $70,000 in the year before the war; to France, $1,630,000 worth, against $2,000 in the year preceding the war; to Italy, $1,182,000 worth, against $11,000 in 1914; to Japan, $3,233,000 worth, against nothing in 1914; to India, $1,948,000, against $93 worth in 1914, and to Brazil, $1,282,000 worth, against $65 in 1914.

Exports of chemicals from the United States in the nine months ending September, 1918, compared with the fiscal year 1914, were as follows:

	1914.	1918.
Acid, carbolic	No data	$1,284,000
Picric	No data	22,275,000
Sulphuric	$126,000	993,000
Other acids	357,000	3,189,000
Alcohol, wood	652,000	1,856,000
Baking powder	790,000	1,177,000
Calcium carbide	962,000	1,079,000
Coal tar distillates	No data	6,480,000
Copper sulphate	330,000	1,210,000
Aniline dyes	No data	5,773,000
Logwood extract	No data	1,312,000
Other dyes and dyestuffs	357,000	4,703,000
Tanning extracts	640,000	2,469,000
Formaldehyde	No data	653,000
Glycerin	No data	7,029,000
Medicinal preparations	6,722,000	7,733,000
Petroleum jelly	662,000	971,000
Potash	No data	880,000
Roots and herbs	513,000	1,520,000
Soda, caustic	No data	4,493,000
Ash	No data	5,184,000
Other salts	No data	5,775,000
Sulphur	2,019,000	2,788,000
Other chemicals	12,948,000	35,388,000
Total	$27,079,000	$126,214,000

Exports of dyes and dyestuffs from the United States for nine months ending September, 1918, compared with the fiscal year 1914, were as follows:

	1914.	1918.
France	$2,000	$560,000
Italy	11,000	530,000
Russia in Europe	3,000	13,000
Spain	......	840,000
United iKngdom	70,000	1,103,000
Canada	129,000	1,012,000
Mexico	1,000	305,000
Argentina	......	567,000
Brazil	65	1,139,000
Chile	1,000	140,000
British India	93	1,003,000
Japan	......	3,319,000
Other countries	140,000	1,258,000
Total	$357,000	$11,788,000

At the annual meeting of the New York Academy of Sciences, held on the evening of December 16, in the Museum of Natural History, all the officers of the organization were reelected as follows: Ernest E. Smith, president; Edmond O. Hovey, Frank H. Pike, George B. Pegram, Pliny E. Goddard, vice-presidents; Ralph W. Tower, recording secretary; Henry E. Crampton, corresponding secretary, and John Tatlock, treasurer.

DU PONT AMERICAN INDUSTRIES

DU PONT DYESTUFFS

What the Ending of the War Means to Our Industry

For more than four years the manufacturing powers of our industries have been almost entirely absorbed in meeting the demand for munitions of war.

As the world's largest manufacturers of explosives our responsibilities have been great—how great may be judged when it is known that since the outbreak of the war—a war in which the quantity of men, munitions and equipment employed, staggers the imagination—we have been the principal source of explosives not only for this country but for our allies.

With the ending of the war that task is done. From now on our entire resources—men, capital and manufacturing facilities—will be devoted to the making of munitions of peace—to the greater task of winning for America's industries a foremost place in the world reconstruction era that is now beginning.

In our dyestuffs industry, the release of labor from our munitions plants, the availability of men trained in the closely allied explosives industry, hitherto unavailable supplies of crudes and intermediates and the possibility of needed extensions in our plant facilities, assure from now on rapid and satisfactory development.

Du Pont Dyestuffs Works

Owned and Operated by E. I. du Pont de Nemours & Co.

Wilmington, Delaware

DU PONT

GLANDER & CO., Inc.

115 Broadway, New York City

OWN and OFFER

DRYERS

2—5'6"x40' direct heat rotary dryers—complete.
1—3'x30' direct heat rotary dryer—complete, with stack.
1—4'x21' Type B double shell Ruggles-Coles dryer.
1—5'x20' Louisville rotary steam heated dryer.
1—72" Ord Standard cooker or dryer, agitated and jacketed.
1—Buffalo vacuum shelf dryer, 11 shelves—complete, with jet condenser and vacuum pump.

PRESSES

3—30" Schriver, 36 plates, 1" cake, center feed.
1—36" Shriver, 42 plates, 1" cake, center feed.
1—3'x4' Type 84M Oliver filter, with receiver, pump, etc.
10—Smith-Vail 15 and 16 box hydraulic presses.

KETTLES

2—5'3"x4' new Buffalo cast iron fusion kettles—complete.
2—4'x5'6" 5/16" steel open top jacketed agitated kettles.
2—6'x10'6" ½" steel cone bottom, closed tanks, with manhole and bottom drop door.
1—4'x7' ⅜" steel, flat bottom, closed tank, manhole, etc., upright.
1—6'x3' open top, round bottom cast iron kettle.
1—32-gallon Pfaudler enameled kettle, agitated.
1—50-gallon Elyria enameled kettle, agitated and jacketed.

KILNS

1—5'x48' rotary kiln, fire brick lining, and castings.
1—5'6"x50' rotary kiln, fire brick lining, and castings.
3—6'x60' rotary kiln, fire brick lining, and castings.

MILLS

1—48"x10' tube mill—Silex lined, pebbles, automatic feeder.
1—44"x25' tube mill—Silex lined, pebbles, automatic feeder.
1—2'6"x1'11" Abbe pebble mill, porcelain lined, with A. C. motor.
1—22"x6' Hardinge conical mill—stone lined, automatic feeder.
1—24" Schultz-O'Neill pulverizer, with dust collector.

STILLS

1—400-gallon Pfaudler enameled stills.
1—200-gallon Elyria enameled still.
1—3'x26' six-section copper still, with condenser and delegmator.
1—5'6" diameter, 28-chamber rectifying column still and kettle—complete, all copper.

TANKS

2—12'x10'x8' deep ¼" square iron tanks.
4—12'x12'x6'4" deep ¼" square iron tanks.
2—12'x12'x8' deep ¼" square iron tanks.
2—10'x10'x7' deep ¼" square iron tanks.

MISCELLANEOUS

1—1½" Gould Triplex plunger pump—bronze fitted.
1—2" Gould centrifugal pump.
1—2" Lawrence two-stage centrifugal pump.
1—2" rotary pump, direct connected to 5-H.P. D. C. motor.
1—No. 4 Figure 198 Rumsey power rotary force pump.
1—24" exhaust fan, with Westinghouse 2-phase, 60-cycle, 220-volt motor.

Fuller description furnished upon request. Always interested in the purchase of Chemical Apparatus.

CHEMICALS
COLORS
MINERALS

For the following Trades:

RUBBER
PAINT
TEXTILE
POTTERY
OIL CLOTH
PAPER
PRINTING INK
LEATHER

KATZENBACH & BULLOCK CO.

New York Trenton Chicago
Boston San Francisco

WE OFFER

Beckmann Thermometers

Calorimeter Thermometers

Normal Thermometers

WRITE FOR PRICES

PALO COMPANY

LABORATORY
APPARATUS AND CHEMICALS
90-94 Maiden Lane, New York City

Classified Index of Advertisers

(Alphabetical Index on Page 443)

Acid Eggs, Stoneware.
- Knight, Maurice A. .... Front Cover

Analytical Chemists.
- Stillwell Laboratories 518

Automatic Liquor Scales.
- Austin, Fred J. 527
- Davis, Charles B. 525
- Gilbert Laboratories .... Back Cover
- Research Laboratories 486
- Reed Laboratories 486
- Stillwell Laboratories 518
- John Simmons Company 484

Bags, Safety.
- Arkell Safety Bag Company 487

Blowers, Fan and Positive Pressure.
- Abbe Engineering Company 524
- Beach-Russ Company 524

Bolting Cloth, Silk.
- Abbe Engineering Company 524
- Beach-Russ Company 524

Books, Scientific.
- Login & Son 527
- Van Nostrand Company 482

Brick, Acid Proof.
- Knight, Maurice A. .... Front Cover

Castings, Chemical.
- Jacoby, Henry E. .... Back Cover

Centrifuges.
- United States and Cuban Allied Engineering Corp. 528

Chemicals.
- Baker, J. T., Chemical Co. 525
- Baker & Adamson Chemical Company 483
- Brenner & Company .... Back Cover
- Garriques, Chas. A., Company 481
- Kaltenbach & Bullock 516
- Richard, M. W. 519
- Virginia Smelting Co. 481

Chemists and Chemical Engineers.
- Austin, Fred J. 527
- Davis, Charles B. 525
- Gilbert Laboratories .... Back Cover
- Research Laboratories 486
- Reed Laboratories 486
- Stillwell Laboratories 518

Chlorinators.
- Wallace & Tiernan 484

Chlorine Control Apparatus.
- Wallace & Tiernan 484

Color Testing Equipment, Ultra Violet Ray.
- R. U. V. Company 521

Compressors, Air or Gas.
- Beach-Russ Company 524

Cooling Towers.
- Coaling Tower Co. ....
- Hart, Jr., B. Franklin & Co. .... Back Cover

Dyestuffs.
- Dupont de Nemours, E. I. & Company 515
- Metz & Company, H. A. 519
- National Aniline and Chemical Company 590

Dryers, Centrifugal.
- United States and Cuban Allied Engineering Corp. 528

Drying Apparatus.
- W. L. Fleisher ....

Engineers, Construction.
- Sutton, Frank 486

AIR
CONDITIONING

Pick Out the
Ideal Day for
Your Product
and We Will
Guarantee to
Reproduce it
365 Days in
the Year

W. L. FLEISHER
& CO., Inc.

31 Union Square
New York
N. Y.

The Stillwell Laboratories, Inc.
Analytical and Consulting Chemists
76½ Pine Street, New York
SPECIALTIES—Fertilizers; Oils, Greases, Glycerine; Food Products; Rubber, Coal; Paint, Ores; Steel, Alloys, Etc.
Factory Control: Erection and Organization; Investigation; New Processes.

POSITIONS WANTED

Chemist, 23, B.S., thorough training, experienced, excellent references, released army, desires opening with opportunity. J. S., The Chemical Engineer 118 East 28th Street, New York City.

CHEMIST—University graduate, some experience, desires position afternoons and evenings, near New York City. Apply C. L., c/o Chemical Engineer.

POSITION WANTED—Three years in chemicals and colors, buying, selling, office work. C. J., c/o CHEMICAL ENGINEER.

CHEMIST—Graduate New York College Pharmacy, part time at Pratt Institute, 16 years' experience in compounding as druggist, desires position requiring knowledge of compounding and analysis. Mehler, 1767 Southern Boulevard, New York.

British Sulphuric Acid Substitutes

One of the largest and most striking economies in the consumption of acid introduced by the Acids Supply Branch of the British Ministry of Munitions has been the industrial utilization of waste products as substitutes for sulphuric acid. The principal of these substitutes is niter cake, a waste product from the manufacturer of nitric acid. Niter cake is produced at the rate of about 28,000 long tons per month, and toward the end of 1915 practically the whole production (then on a smaller scale) was being thrown away—in some cases at a cost of £1 per ton for discharging into the sea or dumping on land. Taking advantage of the control of sulphuric acid, the Acids Branch introduced the industrial use of niter cake into all trades where sulphuric acid performs a somewhat crude function—such as in the textile and dyeing trade, grease recovery, and metal picking. The market price of niter cake consequently rose considerably, and at the present time some 23,000 tons per month are being consumed in about twenty five different trades.

Evaporating Dishes.	
Knight, Maurice A.	Front Cover
Evaporators.	
Jacoby, Henry E.	Back Cover
Filter Presses.	
Abbe Engineering Company	524
Jacoby, Henry E.	Back Cover
Johnson Co., John	482
Lungwitz, Emil E.	488
Shriver & Company, T.	525
Filters, Suction, Stoneware Acid Proof.	
General Ceramics Company	Back Cover
Knight, Maurice A.	Front Cover
Fused Silica.	
Sidio Company of America	482
Gas Machines.	
Detroit Heating & Lighting Company	487
Tirrill Gas Machine Company	523
Gas Control Apparatus.	
Wallace & Tiernan	484
Gaskets.	
Sarco Company	484
Gauges, Recording, Indicating, Pressure and Draft.	
Uehling Instrument Company	Inside Cover
Heating Apparatus and Systems.	
Sarco Company	484
Hydrometers.	
Gottwick, Scheffer & Company	486
Intermediates.	
Dupont de Nemours, E. I. & Company	515
Metz & Company, H. A.	519
National Aniline and Chemical Company	490
Laboratory Apparatus and Caseware.	
Detroit Gas Machine Company	487
Gottwik Scheffer Company	486
Richard, M. W.	519
Tirrill Gas Machine Company	523
Machinery, Chemical.	
Glander & Co.	516
Machinery Utilities Co.	Inside Cover
Consolidated Products Co.	Back Cover
Machinery, Crushing, Grinding and Pulverizing.	
Abbe Engineering Company	524
Machinery, Metallurgical and Mining.	
Abbe Engineering Company	524
Lungwitz, Emil E.	488
Machinery, Mixing and Kneading.	
Abbe Engineering Company	524
Mills, Ball and Pebble.	
Abbe Engineering Company	524
Oil Coolers.	
Hart, Jr., B. Franklin & Co.	Back Cover

Atmospheric Cooling Tower on steel substructure

COOLING WATER IS REQUIRED

for most chemical plants. Why do you buy water and waste it? Buy a cooling tower or spray nozzles and save money by saving water. We make all forms of water cooling apparatus, and every installation we have made has been a success.

Write for our complete catalogue.

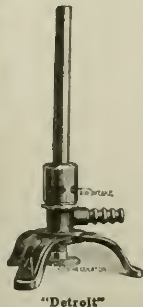
THE COOLING TOWER CO. 11 JOHN STREET NEW YORK

Atmospheric, Fan or Chimney Towers—Spray Nozzles

TERRITORIAL AGENTS

THE C. M. ROBINSON CO., 104 East Court St., Cincinnati, O.
CENTRAL CONSTRUCTION & SUPPLY CO., 2221 Arch St., Philadelphia, Pa.
THE COON DEVISSER CO., Ford Building, Detroit, Mich.
GREAT WESTERN CONTRACTING CO., Kansas City, Mo.

Oxygen.
Beseler Oxygen Company........................ 519
Patents.
Mock & Blum.................................... 523
Parker, C. L................................... 486
Perfumery Chemicals.
Florasynth Laboratories........................ 519
Pumps, Acid or Acid Gases.
Abbe Engineering Company....................... 524
Beach-Russ Company 524
Pumps, Centrifugal.
Abbe Engineering Company....................... 524
Pumps, Rotary, Oil or Water.
Abbe Engineering Company....................... 524
Pumps, Stoneware, Acid Proof.
General Ceramics Company..............Back Cover
Knight, Maurice A.....................Front Cover
Pyrometers.
Uehling Instrument Company...........Inside Cover
Recorders Co.
Uehling Instrument Company...........Inside Cover
Regulators, Pressure and Temperature.
Sarco Company.................................. 484
Safety Bags.
Arkell Safety Bag Co........................... 487
Sterilizers, Ultra Violet Ray.
R. U. V. Company 521
Sterilizing Equipment, Water.
Wallace & Tiernan.............................. 484
Stoneware, Chemical.
General Ceramics........................Back Cover
Knight, Maurice A......................Front Cover
Syphons, Stoneware.
Knight, Maurice A......................Front Cover
Tanks, Cyanide.
Acme Tank Company.............................. 527
Tanks, Stoneware, Acid Proof.
General Ceramics Company..............Back Cover
Knight, Maurice A..............................
Tanks, Wood.
Acme Tank Company.............................. 527
Thermometers.
Gottwik, Scheffer & Company.................... 486
Tower Packing Acid Proof Stoneware.
Knight, Maurice A......................Front Cover
Towers, Acid Stoneware.
General Ceramics Company..............Back Cover
Knight, Maurice A......................Front Cover
Towers, Water Cooling.
Hart, Jr., B. Franklin & Company.........Back Cover
Traps, Steam and Radiator.
Sarco Company 484
Ultra Violet Lamps.
R. U. V. Company............................... 521



Gas for—
laboratory and industrial uses
—automatically made
by the
Detroit Combination Gas Machine
Descriptive catalogue and names of users in your vicinity sent on request.
Detroit Heating & Lighting Co.
616 Wight Street, Detroit, Mich.
Established 1868

"Detroit"
Laboratory Burner

WE OFFER

METHYL
ANTHRANILATE
C. P.

HELIOTROPIN
C. P.

SPOT DELIVERY

Florasynth Laboratories, Inc.
Office, 15 Beekman St., New York City
Works, Unionport, New York
Phones: Beekman 7055-7056

EVAPORATORS
IMMEDIATE SHIPMENT
Copper Heating Surfaces—Good Condition
25,000—10,000—50,000—80,000
gallons of water evaporated per 24 hours
PHONE—WIRE—WRITE
Consolidated Products Company
15 Park Row, New York Barclay 9098

CHAS. V. BACON
Analytical and Consulting Chemist
Chemical Engineer
Control contracts for the coming year
3 Park Row New York, N. Y.

OXYGEN
TO FILL PRESENT NEEDS WE ARE SUPPLYING OXYGEN IN LOW PRESSURE TANKS TO ACCOMMODATE THE TRADE WHO DO NOT REQUIRE LARGE QUANTITIES OF GAS IN ONE SHIPMENT.
BESELER OXYGEN CO.
131-133 E. 23rd St., N. Y. C.

Production of Sulphuric

Arthur E. Wells Estimates Production at 6,300,000 Tons in 1919

THE production of sulphuric acid during 1919 will be about 6,300,000 tons a year, according to estimates prepared for the Bureau of Mines, by Mr. Arthur E. Wells, the metallurgist on the staff of the Bureau. Mr. Wells estimates that the consumption will be in the neighborhood of 4,600,000 tons per year.

Mr. Wells' report reads as follows:

On January 1 of this year the total manufacturing capacity of the country for acid was 427,000 tons per month, (basis 100% H_2SO_4), or 8,200,000 tons per year, basis 50° Be), of which 29% was at contact acid plants.

On November 1 of this year the total manufacturing capacity of the country was 500,000 tons per month, (basis 100% H_2SO_4), or 9,600,000 tons per year, (basis 50° Be.) Of this total capacity 40% was at contact acid plants.

This capacity was divided among (1) Government, (2) explosives companies, (3) all others, including commercial manufacturers, by-product manufacturers, etc., as follows:

	Capacity	
	Expressed as tons per month 100% H_2SO_4	Expressed as tons per year 50° Be.
(1) At Government plants	54,000	1,040,000
(2) At plants of explosives manufacturers	58,000	1,120,000
(3) All others	388,000	7,440,000
	500,000	9,600,000

Inasmuch as the acid market conditions in the inter-mountain and Pacific coast districts are quite distinct from those in the East, and as there has been brought about very little, if any, disturbance in those districts, except for possibly some slight disturbance in the San Francisco district, it is not necessary to include the figures for those districts in the discussions regarding Eastern conditions.

The total capacity east of the Mississippi River, and also including the plant at Argentine, Kansas, and the plants in Louisiana and Arkansas, is as follows:

	Tons per month as 100% H_2SO_4
(1) At Government plants	54,000
(2) At plants of explosives companies	50,000
(3) All others	350,000
Total	454,000

If we assume that the Government plants and the contact plants which were built by the explosives companies primarily to supply acid for munitions explosives, are not operated in 1919, or if operated at all, the production will be utilized only for munitions and thus will not be placed on the market, there remains a total capacity to be considered in the eastern part of the United States amounting to 365,000 tons per month (basis 100% H_2SO_4) or 7,000,000 tons per year, (basis 50° Be).

During the months June, July, and August, 1918, the following industries in the eastern part of the United States consumed approximately the following tonnages of acid:

Industries	Tons per month Basis 100% H_2SO_4
1. Domestic explosives	7,500
2. Fertilizers	109,400
3. Chemicals and drugs, including nitric acid, hydrochloric acid, ammonium sulphate	37,600
4. Oil refining	28,700
5. Steel pickling and galvanizing	36,200
6. Fabrics, textiles, tanning, rubber, paper bleaching	5,100
7. Paints, lithopone, dyes, glue, glycerine, alcohol	7,200
8. Storage batteries, metallurgical work	4,700
9. Miscellaneous and unknown	3,600
Total	240,000

or 4,600,000 tons per year (basis 50° Be).

It is believed that the consumption of acid in the various industries during the period as given above offers a better basis for estimating the future consumption during 1919 than any reference to the figures of 1914. However, it may be stated by way of comparison that in the eastern half of the United States there were consumed in 1914 about 3,500,000 tons of acid (basis 50° Be), according to the figures compiled by the U. S. Geological Survey. From these figures it is evident that between the years 1914 and 1918 there was an increase in the requirements of acid for industries, other than munitions explosives, amounting to about 1,000,000 tons (basis 50° Be). The consumption of acid for fertilizers will undoubtedly be greater in 1919 than in 1918, and will probably average at least 130,000 tons per month (basis 100% H_2SO_4), or 2,500,000 tons per year (basis 50° Be). Thus, with general business conditions favorable, the average monthly consumption of acid in the above industries in the eastern part of the country during the year 1919 should not be less than 260,000 tons per month (basis 100% H_2SO_4), or 5,000,000 tons per year (basis 50° Be). This would require operating all the plants at about 71% of the rated maximum capacity, if the business was distributed over the district proportionately to the manufacturing capacity in the various districts. As a matter of fact, the southern fertilizer plants will probably operate to full capacity, while plants in the Boston, New York, Philadelphia and Baltimore districts may have to average less than 70% of the rated capacity.

The production and consumption of acid in the western half of the United States will probably be about 500,000 tons per year (basis 50° Be), so that the probable total production for the whole country will be about 5,500,000 tons in 1919.

ULTRA VIOLET LIGHT

(Continued from page 506)

and the positions of the maximum and minimum absorption of a number of aliphatic ketones and diketones and ketonic acids, and from their results have drawn the following conclusions. All substances having the general formula $C_nH_{2n}+_1 \cdot CO \cdot C_mH_{2m}+_1$, have an absorption band between λ+2,700 and 2,800, the position and height of the band varying but little with m and n. The method of linking in the alkyl radicles and the position of the ketonic group have a market effect on the value of the coefficient of absorption. The introduction of a second ketone group into the molecule increases the absorption, without altering the position of the maximum. The introduction of the carboxyl group into a ketone has a double effect in that the absorption due to the carboxyl group increased, while that of the ketone group is diminished.

A number of photochemical reactions have been examined by *Henri* and *Wurmser* (Compt. rend., 1913, 156, 230) to see whether Grotthus's law of photochemical absorption, that the photochemical susceptibility is proportional to the absorption, holds good in all cases. For acetone and ethyl acetate the maximum decomposition corresponds with the region of maximum absorption. In the case of acetaldehyde the absorption curve presents a maximum at λ 2,775, then diminishes to a minimum and finally increases steadily for the extreme ultra violet rays, while the decomposition is a maximum at λ = 2,775, and then diminishes, showing no minimum, and being very feeble in the extreme rays. The conclusion is reached that the susceptibility of a substance depends only on that part of the absorption spectrum which corresponds with the same molecular grouping as those on which the action is produced.

Magini (Atti. R. Accad. Lincei, 1904, (v) 13, i, 104; J. Chem. Soc. 1904, Abs., 86, ii, 305) examined the ultra violet absorption of two samples of ethyl acetoacetate, one of which was stated by Schiff to be the pure enolic modification, and the other to consist of about an equal proportion of the enolic and keto-forms. The differences between the two spectra are very slight, as also are those produced by distilling the liquids and do not admit of any conclusion being drawn as to the existence of keto- and enolic modifications ethyl acetoacetate. *Bielecki* and *Henri* (Compt. rend., 1914, *158*, 866) have made a quantitative examination of the absorption spectra in the ultra violet of ethyl and methyl acetoacetates, and ethyl ethylacetoacetate and diethylacetoacetate and substances having allied structures, namely, ethyl crotonate, mesityl oxide, pyruvic acid, ethyl puruvate, and ethyl laevulate.

W. L. Schultz has been appointed New York representative for Roxey, Inc., a Delaware corporation making soap, soap powder and similar products.

available in your own Laboratory

Every Chemical Laboratory should be equipped with a source of Ultra Violet Rays.

The R. U. V. Ultra Violet Ray Lamp is especially recommended to those chemists who have failed to get desired results with the ordinary form of lamp.

POINTS OF SUPERIORITY OF R. U. V.

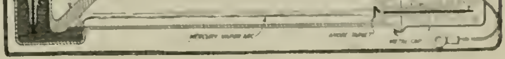
As an indication of its superiority, it has been proven that the R. U. V. Lamp yields twice the usual ultra violet component.

The increased radiation insures rapid developments of possible reactions.

The lamp is adaptable to various kinds of vessels. High efficiency is assured by manufacture of frame from new and clear quartz exclusively.

There is perfect electrical control.

THE R. U. V. CO., Inc.
NEW YORK CITY



Bureau of Mines Report

Director Manning's Report Tells of War Activities of Bureau

HOW a great governmental agency engaged in saving the lives of miners and promoting the welfare of the industry, at the call to arms was instantly turned into an engine of death and destruction to enemies, is detailed in the annual report of the Bureau of Mines, Department of the Interior, by Van H. Manning, the director.

The report, which closes with the fiscal year June 30, while the United States was still at war, tells of the strenuous part played by the Bureau of Mines in assisting to build up the terrifying machine of death that would not have been felt with its fullest force by the Hun until the following spring. With the cessation of war the Germans, it is said, will never be able to realize what the full force of America's military might would have been, or the many devices and methods that were the result of American ingenuity, for the War Department is keeping the best of these a profound secret.

At the same time great good for the future peaceful pursuit of industry in this country and for the saving instead of killing of men has come out of this welter of death-dealing experiments, is the claim of the Bureau of Mines. Certain experiments with delicate instruments known as microphones and geophones, in order to detect the direction and the distance of enemy mining work in tunneling and the location of enemy artillery no matter where placed, has disclosed that these same instruments can be of use in determining the location of men entombed in mines following disaster. It is expected that, if the men have the presence of mind to make even a slight noise, the rescuers listening with these devices will be able at once to locate the men and begin the rescue work. Men thus entombed have been known to live for a week or longer under such circumstances, the rescuers being unable to find them. Other men have died before they could be located. The bureau will equip its rescue cars as soon as possible with these devices.

The war experience of the bureau is going to help peace industries in still another direction. The coal experts, eager to do their share in winning the war, were assigned to the testing of boilers to be used in the ships of the Emergency Fleet Corporation. Speed and the saving of coal were demanded. The result was that the experts so changed the design of the boilers that the coal heretofore necessary to send the ships along for six miles was sufficient to carry them seven miles. This great saving will be available in peace times.

Early in the war every experiment station of the bureau in the mining districts of the country at once closed its peace activities and marshalled for war. The entire bureau and its men and equipment were offered to the two war services. Especially pressing scientific problems were allotted to the different stations, and where the bureau did not have all the men necessary, it turned over its laboratories and equipment to the men assigned by the War and Navy Departments. In this way a central-control laboratory for the testing of materials of war was established at the Pittsburgh station of the bureau by the Ordnance Department. Steel for cannon, material for cartridges and other materials used by the Ordnance were here tested for flaws and weaknesses. The War Department was determined that no soldier, in the emergency of battle, would be able to say that his gun failed him because of faulty material.

The War Department next seized upon the opportunity of using the bureau's explosives station and bomb-proof a few miles from Pittsburgh and there many important, yet secret tests into the action of new and deadly explosives, were made under the supervision of the bureau's and armies' experts. Information of the greatest importance to the war-making powers was obtained.

Early in February, 1917, when war between the United States and the Central Powers seemed inevitable, the bureau offered its services in the study of poisonous gases and gas-masks to the War Department, which was accepted. This was the beginning of the great organization of 1,700 chemists who constituted the Chemical Warfare Service at the American University at Washington and whose jurisdiction was afterwards turned over to the War Department. The bureau claims that as a result of its work, the United States was months ahead of where it otherwise would have been and the soldiers all had gas-masks of such quality that the War Department some time ago issued a statement to the effect that the gassing of a soldier was to be considered in the future as a matter of ignorance. Still further it is claimed by the bureau that through the energy of its research organization, the large-scale production of toxic gases was far ahead of the supply of shells.

Through its investigation of natural gases the bureau with the co-operation of the Army and Navy conducted important work relating to balloon gases. This work included the development of certain products for use in balloons that can be obtained from natural gas. No more can be said about this work at this time.

It was soon found that there would be a tremendous demand by the military authorities for the so-called war minerals. With the havoc wrought by the submarines, the world was short of shipping and the United States was informed that these minerals should come from American mines, many of which were either inadequately developed or not developed at all.

MODERNIZE YOUR EQUIPMENT
Use Gas for YOUR OWN Plant
Eliminate Worry About Coal Shortage and Diminishing Supply of Natural Gas

Gas Easily and Cheaply Made
WITH A
TIRRILL "EQUALIZING" Gas Machine

for Heating—Cooking—Lighting
and all BRANCHES of CHEMICAL INDUSTRIES

Fully guaranteed, easily installed. Affords the *same uses as city gas*. Nothing to get out of order. Does not affect insurance rates.

TIRRILL Combination Mixing Valve
regulates air and gas with one adjustment. Insures maximum of heat with minimum of gas consumption. Adaptable to any kind of gas, and unexcelled for atmospheric burners and apparatus. **Write for FREE Booklet.**

Important.—We are the sole manufacturers of the genuine Tirrill Burners. To avoid getting imitations, order direct from us or write us for the name of the Tirrill dealer in your vicinity.

Tirrill Gas Machine Lighting Co.
Established 1864 619 Terminal Bldg., 103 Park Ave., N. Y.

Sheet metal specialties built to order upon specification.
Let us solve your fuel problems.

TIRRILL Combination Mixing Valve

Hugo Mock *Asher Blum*
Mock & Blum
PATENTS AND TRADE MARKS
CHEMICAL PATENTS A SPECIALTY
220 BROADWAY
NEW YORK CITY

New Du Pont Company Formed

The Dupont Chemical Company has been incorporated at Wilmington, Delaware, with a capital of \$3,600,000 to manufacture chemicals, dyestuffs, etc. The directors are Hunter Grubb, C. R. Mudge and W. S. Thomas, all of Wilmington, Delaware.

It is announced from Wilmington that while the company is authorized to manufacture dyestuffs, its immediate purpose is to take over munitions machinery belonging to the E. I. Dupont de Nemours Company with a view to its ultimate use in other lines of industry. The incorporators are all connected with the Dupont powder interests.

The Evans-Thwing Company, of Fort Worth, Texas, has purchased a tract of land at Hodges Station, Texas, and will in the near future commence the erection of an oil refinery having a daily capacity of 3,500 barrels. The plant will be built upon the unit system. The first unit to be constructed will cost \$600,000.

German Industrial Position

Transfer of Alsace-Lorraine Blow at Nation's Industrial Strength

THE unanimity evident among the Allies regarding the return of Alsace-Lorraine to France, a unanimity which will inevitably result in a transfer of the "lost provinces" and all their immensely valuable natural resources to Allied control, should put an end effectually to any discussion of the possibility of Germany ever again obtaining the strangle-hold on certain chemical industries she possessed before war with the Allies broke out.

Alsace-Lorraine is not only one of the most highly developed manufacturing parts of the German Empire, but it is also one of Germany's chief sources of highly important raw materials. Industries, no matter how shaken they may be by the course of political events, may be reorganized and placed to a great extent on their former footing, but once a nation is deprived of a source of raw materials, such as Alsace-Lorraine, the loss is irremediable.

According to Dr. Felix Pinner, the financial editor of the Berliner Taglebatt, Alsace produced prior to the war 42 per cent of the crude oil produced in the German Empire. Further it contains potash deposits similar in composition to the famous Straasfurt deposits in central Prussia sufficient to assure those who control them freedom from any danger of ever again being placed in the power of the owners of the Prussian deposits. The loss of the Alsatian deposits will unquestionably put an end to the pre-war swashbuckling policy of the German potash barons and force them to either cut prices or make agreements with the owners of the Alsatian deposits.

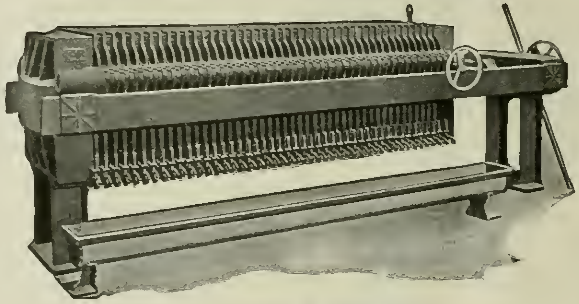
The greatest blow to German industry and its ability to compete with other industrial nations in the markets of the world, will be dealt through the transfer of the Lorraine iron deposits. The amazing development of the German iron and steel industry since 1871 has been due to the possession of Lorraine. The entire iron and steel industry of Western Germany depended to a great extent upon the Lorraine mines. The Lorraine and Luxemburg mines supplied in 1913, 28,500,000 tons of iron ore out of a total of 35,000,000 tons for the whole of Germany. The loss of the Lorraine deposits will, therefore, mean that Germany will have to depend for her ore supply to a great extent on sources beyond her own boundaries.

J. J. McKee, formerly New York manager of the C. A. Dunham Company, of Marshalltown, Ia., is now connected with the Machinery Utilities Company, 501 Fifth avenue, New York City.

E. D. Takamine, 120 Broadway, is New York representative of the Takamine Industrial Company, Ltd., of Japan, which has been authorized to conduct business under the laws of New York State.

Shriver Filter Presses

FOR ALL PURPOSES



SIDE FEED FILTER PRESS

FILTER PRESS PUMPS FILTER CLOTH AND PAPER

SEND FOR CATALOG "B"

T. SHRIVER & COMPANY

Office and Works: 812 Hamilton Street HARRISON, NEW JERSEY

CHEMICAL INVESTIGATION
EFFICIENCY & CONTROL

FOR
MANUFACTURERS
AND CHEMISTS

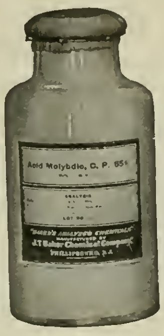
ALL questions, materials for analysis, or letters leading to the opening of negotiations for special chemical research work, will receive prompt attention if addressed to—

Any commercial product reproduced.

Working Formulas
Furnished

DR. CHARLES B. DAVIS
469 W. 152d St.
New York City

On Your Next Chemical Order—



SPECIFY

"Baker's Analyzed"

Chemicals and Acids

After a trial you will specify them on ALL your orders, because you will find them dependable reagents of the highest quality and uniformity.

An Accurate Analysis Appears on the Label of Each Bottle

Catalog on Request

J. T. BAKER CHEMICAL CO.

PHILLIPSBURG, N. J.

EXPLOSIVE FIRMS TO UNITE

Circular Issued by Nobel's Gives Details of Amalgamation in Full

LONDON.—In a letter to its shareholders, Nobel's Explosive Company, Glasgow, gives details of the organization which will eventually link up many of the leading explosive firms and corporations of Great Britain, in an organization with an authorized capital of eighteen million pounds sterling. It is proposed to call the new corporation "Explosive Trades, Limited."

In summing up the statement adds:

"Your (Nobel's) directors are convinced that the closer co-operation to result from the adoption of this scheme is necessary to enable the explosives and allied trades to effectively deal with post-war problems. Such an amalgamation as is proposed will enable the various technical, commercial and financial problems to be more satisfactorily handled, and essential improvements in working conditions, and economies in manufacture and distribution to be introduced, so that the products of the company may be obtained by the consumers on such conditions as will enable the company, their employes and their customers to benefit by this amalgamation.

It is the opinion of W. D. Huntingdon, vice-president of the Davison Chemical Company, one of the largest producers of sulphuric acid in the United States, that conditions in the acid industry will not be seriously affected by the discontinuance of price fixing with the close of the present month.

In an interview given in Washington, Mr. Huntingdon said that for the first quarter of 1919 the prices would be identically the same as those fixed by the War Industries Board for the last quarter of 1918. These prices, he said, would undoubtedly be continued, until such time as there was a reduction in the cost of materials and cost of production.

Mr. Huntingdon further said that all acid produced in Southern plants outside that produced by the Government had been absorbed by the fertilizer industry, which during the year past had not been able to obtain an adequate supply.

It is the desire of the American Committee of the Ramsay Memorial Fund to make the fund an expression of the esteem for Sir William Ramsay in this country. Many have expressed a wish to contribute, but have held back on account of their inability to send in a sum commensurate with their esteem. This has been due to the numerous calls made upon all for the past two years. Small sums, from one to five dollars, will be welcomed by the committee, which is anxious to make the expression of appreciation as widespread as possible. Contributions may be sent to Prof. Charles Baskerville, chairman, College of the City of New York, or Mr. W. J. Matheson, treasurer, 21 Burling Slip, New York City.

NEW PUBLICATIONS

SUBSTITUTION OF NITRE CAKE FOR SULPHURIC ACID IN PICKLING STEEL.

E. E. Corbett, Chemical Engineer, Bureau of Mines, Department of the Interior, Washington, D. C.

While the investigation which resulted in the publication of this paper was undertaken primarily for the purpose of finding a means of conserving sulphuric acid, a commodity at that time very much needed in the manufacture of war materials, has at first sight been made unnecessary by the coming of peace, the thoroughness with which the author has investigated the question of the pickling of steel, will make his paper interesting and useful to chemists allied with the steel industry.

NOTES ON LIGNITE—ITS CHARACTERISTICS AND UTILIZATION.

S. M. Darling, Bureau of Mines, Department of Interior, Washington, D. C.

Designed to be read in conjunction with Bureau of Mines bulletin No. 89, "Economic Methods of Utilizing Western Lignites," and the report on "The Carbonizing and Briquetting of Lignite," issued by the Province of Saskatchewan, Canada, this publication of the Bureau of Mines with the aid of these other publications gives a comprehensive review of all information at present available in regard to the location and nature of the various lignites available in the United States and Canada.

There are, according to the author, 1,051,290,000,000 tons of lignite available in the United States, the greater part of it located in parts of the country that lack other adequate fuel resources. An effective use of the lignite resources of the country would not only, therefore, place at the disposal of these lignite districts an adequate fuel supply but would eliminate a great deal of wasteful transportation of coal over long distances, thereby relieving strain on the railroad systems and mines of the country at certain seasons of the year.

The author of this paper does not advocate the use of lignite in its raw state, this he rightly points out is impossible to any great extent, owing to the high percentage of moisture in the material and the difficulty experienced in handling it.

Instead of trying to burn the raw lignite, it may be used in a number of forms: (1) as dried lignite, the material being handled mechanically; (2) powdered fuel in cement kilns, railroad locomotives and other furnaces; (3) dried lignite briquets; (4) carbonized lignite, for use in suction power gas producers; (5) carbonized lignite briquets for domestic service in house heating stoves, and furnaces, fireplaces and cooking ranges. This latter fuel compares favorably according to the author with anthracite coal; (6) sulphate of ammonia and producer gas. The raw lignite when used in by-product gas producers of the Mond type, make sulphate of ammonia, produces gas and some tars of undetermined value.

NEW BAUMÉ SCALE FOR SUGAR SOLUTIONS

Bureau of Standards, Department of Commerce,
Washington, D. C.

Many different Baumé scales have been proposed and used in the past. At the present time there are still in use in the United States three different scales for liquids heavier than water. Two of these, namely, the "Holland" scale and the "Gerlach" scale are used in sugar work. Neither is adapted to modern requirements. The new table lies between the "Holland" and "Gerlach" scales and has three important advantages which should commend it for general use. They are: 1. It is based upon the specific gravity values of Plato which are considered the most reliable of any available. 2. It is based on 20°C, the most convenient and widely accepted temperature for sugar work. 3. It is based on the modulus 145, which has already been adopted by the Manufacturing Chemists Association of the United States, by the Bureau of Standards and by all American manufacturers of hydrometers.

This paper is now ready for distribution and those interested may obtain a free copy by addressing a request to the Bureau.

PAPERS AND ADDRESSES—Technical Association of the Pulp and Paper Industry—New York—64 pp.—$1.00.

This publication is a compilation of the papers and addresses delivered at the annual meeting of the Technical Association of the Pulp and Paper Industry held in New York City, in February last. While most of the papers have been published this collection should prove a valuable addition to the reference library of any chemical engineer. Copies may be obtained from the Secretary of the Association.

COLLOIDS AND FLOTATION—Frederick G. Moses—United States Bureau of Mines—Washington, D. C.—24 pp.

This paper is an attempt to point a way towards the elimination of certain troubles hitherto unexplained, experienced in the operation of flotation plants. These problems are considered in the light of certain facts of colloidal chemistry and physics.

After an exhaustive discussion of the usual difficulties encountered due to the presence of colloids, the writer comes to the conclusion that colloids interfere greatly with flotation and that in order to overcome this difficulty their removal is necessary. He points out that there are various ways of removing irreversible colloids, principal among which he mentions heating of the ore.

ANALYTICAL AND CONSULTING CHEMIST
MATERIALS ANALYZED—RESEARCH WORK.
FACTORY PROCESSES INVESTIGATED.
FRED'K J. AUSTIN, 119 Nassau St., N. Y. C.

COTTON DUCK
AND
FILTER CLOTHS
COTTON FILTER CLOTHS
WOOL FILTER CLOTHS
and
FILTER PRESS SACKS
for
CHEMICAL and INDUSTRIAL PURPOSES
W. W. STANLEY
50 Church Street, New York City

CHEMICAL MAGAZINES
BACK COPIES OF DOMESTIC AND FOREIGN PERIODICALS FOR SALE. WE BUY SETS, VOLUMES, AND NUMBERS.
B. LOGIN and SON
152 EAST 23rd STREET, NEW YORK CITY

PAPER, PAPER PRODUCTS AND PRINTING MACHINERY IN PERU, BOLIVIA AND ECUADOR—Robert S. Barrett—Department of Commerce—Government Printing Office—10 cents.

Government experts are not inclined to be over sanguine in regard to the new gasoline substitute, recently announced from Washington. The "Liberty Fuel," which is based upon kerosene, is being subjected to further tests and it is likely that an official announcement will be made shortly by responsible officials.

According to Dr. Sidney B. Haskell, business manager of the Soil Improvement Committee of the National Fertilizer Association, the production of the potash lakes of Nebraska is steadily increasing. Potash actually in storage on October 30 last amounted to 40,000 tons. The actual total production during 1918 will be between 30,000 and 32,000 tons. During 1919 it will likely be about 40,000 tons.

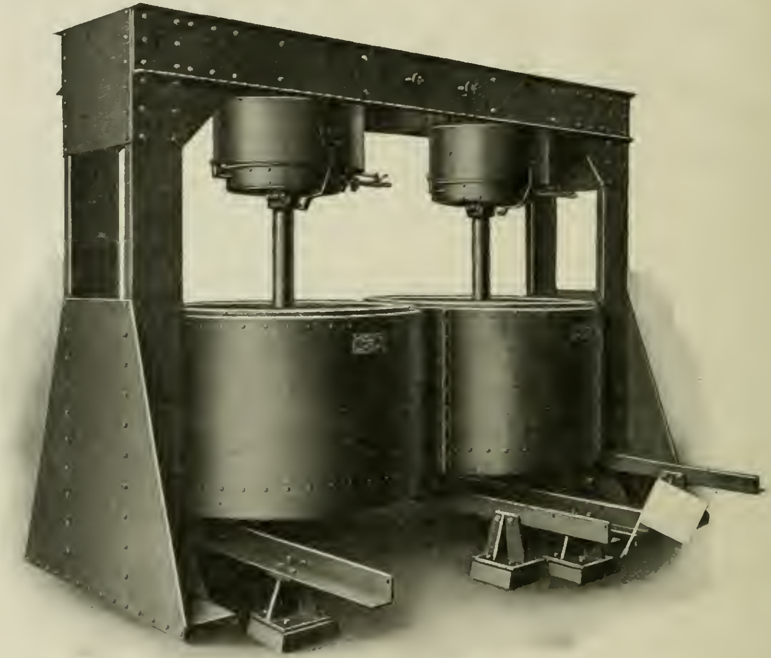
A great deal of damage was done at the plant of the American Aniline Products Company, 66-68 University Place, New York City, by the explosion of a drum containing alizarine dye.

A meeting of the Chicago section of the American Chemical Society was held at the Chicago City Club of December 13. The program consisted of a report on the present employment of women chemists.

ANY SIZE OR SPECIFICATION
Three factories, situated in the East, Middle West and Pacific Coast, enable us to give you special service in the manufacture of tanks.
We have on hand reserve supplies of air-dried woods suited for the different chemical requirements, making prompt shipments possible.
Our many years' experience in handling tanks to standard and special specifications should be of value to you. Your specifications will have our immediate and careful attention.
ACME TANK COMPANY
37 Cortlandt Street, New York City Telephone: Cortlandt 2520

Centrifugals

FOR THE CHEMICAL INDUSTRY



The above illustration shows two of our latest improved 42-inch specially designed standard Weston Centrifugal Machines for service in the manufacture of Explosives and Sulphate of Ammonia (coke oven by-product).

We specialize in direct connected, electric motor-driven water- and belt-driven centrifugals. They are designed with a minimum number of parts and are of simple and rugged construction with few lubrication points. Sizes from 30 inches to 72 inches in diameter.

Complete specifications on request.

UNITED STATES & CUBAN ALLIED WORKS ENGINEERING CORPORATION

NEW YORK OFFICE
50 Broad Street

Factories
BRADFORD, Pa HAVANA, Cuba

HAVANA OFFICE
Cuba 84

TP
1
C32
v.25-26
[redacted]

Engineering

Chemical age

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

ENGIN STORAGE